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A BIOGRAPHY OF THE ANGOUMOIS GRAIN MOTH.

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I. PROLOGUE.

About two hundred years ago Monsieur Baron, a physician in the Commune of Luçon in the Province of Poitu (the Departments of Vendée, Deux-Sèvres, and Vienne of modern France), discovered that the barley in his granary was giving rise to many active little buff-colored moths. Wishing to know more about these strange insects, the doctor made observations of their habits and also sent specimens for identification to Monsieur R. A. F. de Réaumur, the celebrated naturalist and inventor. M. de Réaumur proceeded to study their activities and structure, and later included an account of his findings in his well-known *Mémoires pour Servir a l'Histoire des Insectes*, published in Paris, 1734 to 1736.

The story of this insect during the two eventful centuries since its first recorded association with mankind in the Commune of Luçon has been written in more than five hundred installments and in various languages. The present narrative attempts to assemble and condense the scattered parts into a relatively brief account of the advances and retreats of the species, of the hard living and economic waste occasioned by it, and of the ways in which it has been both a stimulant to invention and a useful ally of science.

II. THE MOTH.

It is appropriate to introduce the moth to those not familiar with it by reviewing in a few words the facts about its systematic position, appearance, habits, and natural enemies. After

having been placed originally in the genus *Alucita* by Olivier, the insect has been assigned at different times to the genera *Œcophora*, *Tinea*, *Phalena*, *Ypsolophus*, *Anacampsis*, *Pyrophagella*, *Butalis*, and *Gelechia*. It is known at present as the species *cerealella* of the small genus *Sitotroga*, family *Gelechiidae*.

The adult insect usually measures about one-quarter inch in length when the wings are folded along the body in the normal position. According to the literature, the color of the moth is as follows:

> the color of *café-au-lait*, almost the color of wheat; clear brown, a little grayish; gray, grayish brown, brownish gray, pale ash color; brick color, more or less light and glossy; yellowish, ochreous, pale glimmering ochre, pale brownish-buff color with a satin like lustre, pale shining ochre, obscure yellow or yellowish brown, straw colored, uniform silvery dull yellow, pale yellowish, light brown satin color, yellowish gray, grayish yellow, buff color with a satiny luster, fawn or light gray, light grayish brown, soft shiny light gray, whitish, yellowish white, grayish clay-yellow, light-yellowish irridescent brown, and pale brown.

About twelve days is the average length of life of the moths. The females ordinarily lay from 50 to more than 300 white eggs which, in a day or so, assume a vivid red color. The eggs are laid both on stored grain and on that which is ripening in the fields. Diminutive caterpillars chew their way out of the eggs after from four to ten days and promptly give up their freedom by gnawing into grains of wheat, maize, or other seeds of sufficient size. Growth having been completed—by which time, in the case of small grains such as wheat, the substance of the seed has been largely consumed—the larva clears away all the endosperm from a small area of the seed coat and cuts through the latter around nearly the whole circumference of a circle, leaving a frail lid which offers little resistence to the emergence of the winged adult. A cell is then formed among the pellets of excreta with which the eaten-out seed is partially filled, metamorphosis occurs, and the moth pushes its way into the open air. The adults are unable to feed and of course do no direct damage.

The life cycle is about five weeks. These life cycles, prolonged during cold weather to five or six months, have been following one another in man's grain crops for at least 200

years, and probably for a very much longer period. Unfortunately the favorite foods of the insect are the staple cereal foods of man—wheat, maize, barley, and rice. Considerable damage has been done also to the seeds of several varieties of sorghum (Kafir corn, milo, broom corn, Sudan grass), and oats, rye, cowpeas, chickpeas, buckwheat, sweet corn seed, popcorn, beans, and the seeds of bamboo are subject to infestation.

It is not alone the loss of food for man and domestic animals for which the insect is responsible; injury to grains reserved for planting results in economic waste. The embryos of small seeds are usually destroyed or injured by the feeding larvae, preventing germination, and even though the embryos of many infested grains escape destruction, the reserve food supply is often so reduced in amount as to prohibit normal growth of seedlings.

The most effective enemy of *Sitotroga cerealella* is the predacious mite *Pediculoides ventricosus* Newport, which in its nymphal stages is of microscopic size. When the larvae, pupae, and even the adults of the moth are attacked by large numbers of *P. ventricosus*, persons handling the threshed or unthreshed infested grain experience the decidedly memorable sensation of going up in flames. The dermatitis occasioned by severe attacks of the mite has been referred to as "straw disease," the blame for the trouble usually being placed upon the moth itself.

III. THE MOTH IN EUROPE.

For a number of years prior to 1759 the Angoumois grain moth, usually called *l'alucite* (Latin *alucita*, a gnat) by French writers and also referred to as *la lucite*, *teign des blés*, *papillon*, and *pou volent*, had been taking a varying toll from the wheat crop in the vicinity of Angoulême, chief city of the Province of Angoumois (now the Department of Charente) in west-central France. By 1759 it had assumed the proportions of a plague and was abundant in neighboring regions also, including the Province of Poitou, from which it had been reported for the first time by M. Baron some thirty years before. The insect was present as far west as La Rochelle, which may well have been its port of entry.

In 1760 M. Pajot de Marcheval, overseer of the tax district of Limoges, of which Angoumois was a part, took notice of the distress and:

> ". . . reported it to the Court with the zeal of a good citizen and with the energy which the sight of such misery inspired in a magistrate really affected by the plight of a province entrusted to his care."[1]

M. de Marcheval addressed an appeal for assistance to the Comptroller General, an appeal which "made such an impression upon the heart of the Comptroller General" that he wrote to the Royal Academy of Sciences recommending that the Academy make the necessary investigation by sending two of its members to Angoumois before the grain harvest began.

The Academy chose as its representatives Henri Louis Duhamel du Monceau, a versatile scientist and prolific writer, and Mathieu Tillet, a younger man, who went to Angoumois and undertook what was probably the first field investigation in economic entomology, of the modern type. They continued their work through two summers, making headquarters in the Chateau de Larochefoucauld. The report of their study is still among the outstanding monographs of the literature of economic entomology. They observed nearly every detail of the life history of *l'alucite*, its habits and capacity for damage, and offered sensible suggestions for control.

Among the matters discussed by du Monceau and Tillet in their report were: the biological heating of infested grain when stored in bulk; the activities of swallows that fed upon the moths; the infestation of ripening wheat, especially in the vicinity of infested stored wheat; the results of sowing infested seed wheat; the ability of the adults to escape from planted grain; the effects of weather on moth abundance; the degree of infestation found in wheat; parasitism of the larvae; the benefits to be derived from cool storage; and methods for heating infested wheat in kilns. They suggested the use of police power to enforce general clean-up operations and the application of quarantine restrictions for the purpose of preventing the further spread of the insect by requiring all infested grain to be heated before being transported to uninfested areas.

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[1]Histoire d'un Insecte qui devore les grains de l'Angoumois; avec les moyens que l'on peut employer pour le détruire, by H. L. Duhamel du Monceau and M. Tillet. 314 pp., 3 pl. Paris, 1762.

Some of the farmers of Angoumois had found that piling their threshed wheat resulted in lesser damage than when the grain was spread out on the barn floors. In some cases the wheat was mixed with salt and sprinkled with vinegar, with indifferent success. Other methods of control tried by the growers included covering the grain with odoriferous herbs, rubbing the grain shovel with spikenard oil or spirits of turpentine, dipping the wheat in boiling water, fumigation with sulphur, whitewashing the walls and floors of the granaries with lime or rubbing them with garlic, the putrid urine of cows, or with "mercurial preparations." Du Monceau and Tillet decided that all of these were useless except boiling water and sulphur fumigation, neither of which was wholly effective and both of which were impracticable for use by most of the inhabitants. They recommended that wheat for planting be dipped in a solution of lime and lye and that grain for bread making should be heated in the large bread ovens of the region.

Aside from the original technical description of *l'alucite* by Olivier in 1789 and his discussion of its habits, nothing further of importance appeared in the French entomological records during the 18th Century. The moth apparently became troublesome again about 1829 to 1831 when Jean-Jacques Colin found that sealing infested grain in tight containers was fatal to the insects. Heat, cold, sulphur fumigation, carbonic acid, chlorine gas, lime, copper sulphate water, heavy smoke, and "the flaming action of a good electric machine" were tried at this period; and a heat machine, the "trogoctone," was invented. In 1836 Mattieu Bonafous stated that the European wagtail, a small insectivorous bird, had been used for moth control in granaries "not without success."

During the thirties J.-Ch. Herpin (1838) and others turned their attention to mechanical means for destroying the insects within infested wheat and for crushing or dislodging eggs deposited on the grain. The idea was to subject the kernels to violent concussion. In 1850 Herpin, whose work with *l'alucite* extended over many years, was awarded a gold medal in recognition of the invention of his shock machine. Louis-Michel-François Doyère, in 1854, also was awarded a prize for the invention of a mechanical shock machine, but Herpin protested Doyère's claim to priority and a committee appointed to investigate the facts found in favor of Herpin, in 1855.

Doyère was active in publishing information about the moth, and Herpin likewise published extensively. An article by the latter[2] is of unusual interest. He explained the construction and operation of heat machines of various types, one form being made on the principal of a coffee roaster—a forerunner of the revolving-cylinder machines which have come into use in recent years in Egypt and in the United States for treating cotton seed infested by the pink boll worm. He reported upon experimental apparatus wherein steam was used as the insecticidal agent. But Herpin's description of the method of vacuum fumigation, essentially the same as now employed quite extensively, especially in the United States, is his most interesting contribution:

> "The moth resists, in part at least, exposure to a vacuum for one or two days. However, if one substitute for the air some deleterious gas (sulphurous, nitrous, ammonia gas, the vapors of ether, chloroform, carbon disulphide, etc.) the anaesthesia or the death of the insect takes place very promptly. The construction and use on a large scale of a well-arranged apparatus based on these principles do not present any serious difficulty. This apparatus will consist of two cylindrical vessels of sheet iron, similar to the boilers or heaters of steam engines, each one containing 10 to 20 hectolitres of grain. Between these two vessels will be placed an air pump, prepared and operated in the manner of a fire pump, communicating with the two vessels. These cylinders being alternately filled with grain and well closed, the air is removed with the pump, after which the lethal gases are introduced by opening a plug communicating with a balloon in which the gas is prepared. One of the vessels is operated while the other one is being charged."

Herpin described in convincing language the bad effects of the use of infested wheat for flour:

> "The larvae are sometimes so numerous that if we squeeze a handful of wheat there is expressed a white, viscous fluid which is the substance of the crushed insects' bodies. . . . The bread which is made from the infested wheat, chiefly when the flour has not been suitably bolted, contains some débris of dead bodies and excrement of the insects. It has a disagreeable, loathsome taste, sticks to the throat, lacks cohesion, and falls apart in water as if it were made of dirt. To this unhealthy food is attributed a bad throat condition which prevailed for several years, to an epidemic

[2]Sur *l'alucite* ou teignes des blés et sur les moyens de la détruire. Comptes Rendus de la Société du Berry à Paris, 7 année, 1859–60, p. 93–115.

> extent, in the countries affected by *l'alucite*. This illness is characterized by gangrenous ulcerations which form in the back of the throat. The patient succumbs in a few hours, even before it has been possible to administer help."

L'alucite was associated, also, with the discovery of carbon disulphide, a fumigant that has been more widely used than any other for the control of insects infesting stored grains. In this matter, as in that of the shock machines, Doyère was involved in a controversy about priority of discovery. He published an account of his discovery of the insecticidal value of carbon disulphide in 1857, but it developed that Dr. Lazare Garreau had published on the subject three years before. The two men apparently made the contribution independently, in the course of their efforts to find measures for the control of *l'alucite* and other grain-infesting insects.

Since the time of Herpin and Doyère, little original work has been published in France on the subject of *l'alucite*. We may turn to a recent writer, Valéry Mayet (1899), for a survey not only of this period, but of the period of activity which closed with Doyère and Herpin. Mayet's explanation of the disappearance of the plagues of *l'alucite* that formerly ravaged French wheat harvests is that since the middle of the 19th Century transportation facilities have made it possible to supplement a small wheat crop in France with prompt importations, thereby removing the advantages gained by the practice, formerly common among the farmers, of speculative hoarding.

The foregoing opinion as to why *l'alucite* became of minor importance in France probably does not wholly decide the question. Whatever the reasons may be for the insect's decline in that country, its disappearance there as a species of economic importance has occurred. A letter received by the writers in 1924 from the office of the Chief Entomologist of France, Dr. Paul Marchal, affirmed that infestation by the moth has been in very mild form for so many years that it passes almost unnoticed. Correspondence with entomologists in the region where Du Monceau and Tillet carried on their investigation failed to discover the reasons why outbreaks of *l'alucite* have ceased to arise there.

IV. THE WORLD-SPREAD OF THE MOTH.

The geographical divisions of the world in which *Sitotroga cerealella* has been known to occur include the following 51 countries, colonies, and islands, but the list is probably not complete.

Algeria.....Prevalent. Three or four generations per year.
Argentina.....Common near Buenos Aires in 1874. (First record in South America.)
Australia.....Caused serious damage in 1889; frequently injurious to maize.
Austria.
Belgium.
British Guiana.....Attacks barley, both in storage and in the field.
British Isles.
Bulgaria.
Burma.....Known as the paddy grain moth.
Canada.....Unimportant because of cold climate; frequently imported.
Canary Islands.
Ceylon.....Observed infesting rice.
Corsica.
Czechoslovakia.....Has been reported as far north as Prague.
Dutch Guiana.
Egypt.....Chiefly injurious to barley.
Federated Malay States.
Fiji Islands.
France.....Known as a pest before 1736. Formerly caused great losses.
French Indo-China.....Attacks rice.
Germany.....Not common.
Hawaiian Islands.....First recorded in 1909. Attacks harvested and standing rice and stored maize.
Hungary.
India.....Sporadically a major pest. Originally recorded in 1891.
Italy.....First reported in 1759. Five annual generations in southern Italy.
Italian Libya.....Observed infesting barley in Cyrenaica.
Jamaica.
Japan.....A pest of rice, maize, wheat, and buckwheat.
Java.....An enemy of rice.
Madagascar.....Attacks rice.
Madeira Islands.
Malaya.....One of the five leading insect pests of stored rice.
Mexico.....Recorded for the most part as infesting maize.
Netherlands.
New Zealand.
Nyasaland.....One of the two most destructive stored-grain insects.
Philippine Islands.
Poland.
Porto Rico.....An important pest of maize.
Rhodesia.
Rumania.
San Domingo.....An enemy of maize.
Sierra Leone.
Spain.....One of the four principal stored-cereal insects.
Sweden.
Tanganyika Territory..Infests cowpeas, beans, sorghum, and bulrush millet.
Tunis.

U. S. S. Republics.....In some years very destructive, especially to maize, in southern European areas and in Transcaucasia. Recorded from Siberia.
U. of South Africa.
U. S. of America.....Became established about 1730. Heavy losses continue to occur at intervals.
Uruguay.....An important enemy of cereals.

V. EARLY HISTORY OF THE MOTH IN THE UNITED STATES.

In the United States *Sitotroga cerealella* has been known by about twenty common names, of which "Angoumois grain moth" is the accepted one. The name is long, difficult, or impossible to pronounce correctly, and not particularly suitable. If it were not too late, a substitute might be selected from the following names which have been used in this country: butterfly, fly, flying weevil, fly moth, fly-weevil, grain moth, grain worm, gray weevil, Hessian fly (confused with the true fly of that name), miller, moth, moth weevil, stack fly, Virginia fly, weavil, wevil, weevil, weevil fly, wheat-moth, wheat weevil, white fly, and white weevil. In addition, Angoumois moth and Angoumois wheat moth have been employed, and the geographical part of the name has appeared as angoumois, Angumois, Angonnois, and even as Angamnois. Of the above the combination "wheat moth" is appropriate, brief, and not susceptible of being confused with the name of another insect. For the reasons mentioned and to conserve the energies of the reader (but with no hope of starting a reform), the writers will take the liberty of using this name throughout the recital of the history of the insect in the United States.

On November 15, 1768, a paper entitled "Observations concerning the fly-weevil, that destroys the wheat, with some useful discoveries and conclusions, concerning the propagation and progress of that pernicious insect, and the methods to be used to prevent the destruction of the grain by it," by Col. Landon Carter, of Sabine-Hall, Virginia, was read before the American Philosophical Society. Carter reported that he cut his wheat as early as possible, piled it in mows, and packed hay tightly around it. He further stated that he had had experience with the moth for twenty-five years and that weevily wheat makes flour that causes "a prodigious clamminess" of bread. The Colonel had planned a gas attack upon these insects in his wheat fields, to consist of burning orpiment (arsenic trisulphide) to windward, but gave up this 20th Century idea because of

the danger of including among the casualties some of his less resourceful neighbors.

Following Carter's article, the Committee of Husbandry of the Society published a more comprehensive discussion of the insect. Injury to wheat by the moth, according to the committee's report, began in North Carolina about 1730:

> "These mischievous flies have extended gradually from Carolina into Virginia, Maryland, and the Lower Counties on Delaware; to the last of which places they did not arrive 'till seven years ago, and had not yet penetrated into Pennsylvania, or passed the Delaware."

For control the committee suggested the use of burning charcoal or burning tobacco stems. Corn also was injured, but might be preserved by storing with the husk on, and bulk grain should not be stirred but should be allowed to become encrusted on the surface, thereby preventing infestation of the grain lower down.

Professor E. O. Essig evidently had in mind the above articles, published in 1771 in Volume 1 of the Transactions of the American Philosophical Society, when he wrote (1926) that this species "was the first insect discussed in an American scientific publication."

It is significant to recall that injury was first noticed in France at about the same time as in the American Colonies, which suggests that the infestation in both countries had a common origin elsewhere. Had the wheat moth been indigenous to either region, a species unique in its habit of making a trap door in the grain kernel, capable of rapid increase in food supplies of great importance, and conspicuous in the adult stage, must have been observed if present much before 1730.

The writings of Thomas Jefferson contain several references to the wheat moth. In his *Notes on Virginia*, dated 1782 and published in 1784 in Paris, Jefferson observed, with reference to wheat, that

> "The weavil indeed is a formidable obstacle to the cultivation of this grain with us."

In a letter to John Adams, November 27, 1785, he wrote that in sending grain to Portugal

> ". . . much is lost by the weavil, and much spoiled by heat in the hold of the vessel."

Included among Jefferson's collected writings is a letter written by Thomas Paine, ambassador to Great Britain, to President Washington. The letter, dated London, March 12, 1789 (eight days after Washington's inauguration), reported that

> "The acts for regulating the trade with America are to be considered as last year. A paper from the Privy Council respecting the American fly, is before parliament. I had some conversation with Sir Joseph Banks upon this subject, as he was the person whom the Privy Council referred to. I told him that the Hessian fly attacked only the green plant, and did not exist in the dry grain. He said, that with respect to the Hessian fly, they had no apprehension, but it was the weevil they alluded to. I told him the weevil had always, more or less, been in the wheat countries of America, and if the prohibition was on that account it was as necessary fifty or sixty years [ago] as now; that I believed it was only a political maneuvre of the ministry to please the landed interest, as a balance for prohibiting the exportation of wool, to please the manufacturing interest."

Jefferson again referred to the insect in a letter to Gouverneur Morris, written in Philadelphia, June 13, 1793:

> "Though our spring has been cold and wet, yet the crops of small grain are as promising as they have ever been seen. The Hessian fly, however, to the north, and the weavil to the south of the Potomac, will probably abridge the quantity."

According to Wm. M. Walmsey (1805), the wheat moth was first noticed in abundance in the vicinity of Byberry, Pennsylvania, about 1784. The cold winter of 1784–85 apparently killed the insects, for none were seen until 1794 or 1795 when considerable damage was done about nine miles above Pennypack Creek. The cold of the following winter, he stated, destroyed them all. They appeared in small numbers in 1801, and were very abundant in wheat by August, 1802. A few were found in rye and barley. In 1803, wheat and rye were both seriously attacked.

John Lorain wrote, in 1811, that perceptible damage to wheat began on the Eastern Shore of Maryland about 1766 and that infestation had been irregular and local since that time. It had long been known, he remarked, that early threshing and bulking brought on a heating or sweat that quickly destroyed the insects:

> "Sweating is prodigious, and rising to the top of the heap, forms a moldy crust several inches deep in which the heat vegetates,

> and spreads a pile of foliage over the whole resembling a field only vastly thicker set: yet under this crust the grain becomes dry and perfectly free from all damage, except what had been sustained before it had been put into bulk."

Lorain observed that wheat may be so badly damaged that pigs refuse to eat it, and that bread made from considerably damaged wheat

> ". . . has a very ill taste, and when cut into pieces resembles boiled liver and certainly cannot be wholesome."

One of the early recorders of damage by the wheat moth in the colonies was L. A. G. Bosc, who published his account in France in 1813. He had seen the insect so abundant in Carolina that it sometimes extinguished his light when he entered a granary after dark.

As in the days of Du Monceau and Tillet in Angoumois, so in the early days of agriculture in the United States, some farmers believed that the generation of the wheat moth was spontaneous—"a vegetable insect," "the natural production of the grain," etc. They were, moreover, handicapped by lack of information about insect control, and as a consequence a number of ineffective methods were tried and believed to be useful. Among such were the use of loose salt, brine, lime, the stalks and leaves of elder (*Sambucus* sp.?) and the leaves of wax myrtle (*Myrica cerifera*) and of Pride of China (*Melia azedarach*).

By the year 1829 the wheat moth was established at Lexington, Kentucky, perhaps the first record west of the Allegheny Mountains. Attempts at control were being made near Lebanon, Ohio, as early as 1831. According to Carl Sandberg a song called *Weevily Wheat* was popular among young folks in Indiana during the boyhood days of Abraham Lincoln. Mark Sullivan (*Our Times*, vol. 2) has supplied one of the verses, contributed by former Governor Chase S. Osborn of Michigan:

> "We don't want none of your weevily wheat
> And we don't want none of your barley;
> Nothing but the best of wheat
> To make a cake for Charley."

Apparently others than Colonel Carter had had experience with the "prodigious clamminess" of bake-oven products made from weevily wheat, and a couple of good old double negatives were quite fittingly used to emphasize the fact.

In 1833 Edmund Ruffin, proprietor and editor of the *Farmers' Register*, published at Shellbanks, Virginia, contributed to his columns an excellent article on the "moth weevil." He asserted that the limits of the range of the insect were sometimes greatly contracted, for years at a time, by spells of severe cold weather. The fact that stored corn is the source of the greater part of the moths which infest ripening wheat in the eastern part of the corn and winter wheat belt was first understood by Ruffin. Ruffin was also one of the first to observe that infestation of ripening corn in the field occurs for the most part in the tips of ears imperfectly protected by shucks.

Considerable damage was caused in 1844 and 1845, especially in the former year, in the southwestern corner of Indiana, as pointed out in an article by Richard Owen. In 1844 the wheat he threshed on September 2 from 40 acres was so badly eaten that he had to sell it to a distillery, then the customary way of disposing of such grain in Indiana. During 1847 Ruffin published further on the insect. He affirmed that in some parts of Maryland it had been absent during such long periods as to have been almost forgotten, only "to reappear and become for a time very numerous and destructive." At times it had been almost extinguished even in lower Virginia.

VI. LATER HISTORY OF THE MOTH IN THE UNITED STATES.

Although a number of well-qualified observers recorded their knowledge of the wheat moth up to the ending of the first half of the 19th Century, the insect did not receive much attention during those years from the few trained entomologists who were at work in the United States. Since 1850, however, the chief contributions to our knowledge of the species have been prepared by entomologists. But in the course of the forty years following the publication of the last of Ruffin's discussions only three writers, all entomologists, made noteworthy contributions on the subject: Thaddeus W. Harris, F. M. Webster, and C. V. Riley. Harris (1852) prepared, in popular language, a good description of the species. Webster supplied, in 1883, descriptions of the larval and pupal stages and described one of the parasites of the larva, *Pteromalus gelechiae*. Some years before, according to Webster, the *New York Sun* had expressed the opinion that if the Government could exterminate the moth for $5,000,000 it would be the best investment ever made by the people.

Riley's *Report of the Entomologist (of the U. S. Department of Agriculture) for 1884* contained a summary of information on the wheat moth. Riley was the first in the United States to recommend the use of carbon disulphide against the moth, the original recommendation having been made by him, according to his 1884 *Report*, in an article published in the March, 1879, issue of the *Farmers' Review*. The value of our present prompt distribution of scientific results and ideas is illustrated by the delay of twenty-five years which intervened between the discovery in France in 1854 of the insecticidal value of this fumigant for the control of grain-infesting insects and Riley's suggestion that it be used in the United States.

There appears to have been extensive damage to wheat in parts of the eastern wheat region in 1891 and even more in 1892. Publications on the wheat moth and communications to the agricultural press increased markedly in number, reflecting an active demand by wheat growers for information which would help them to control infestation. Instances were reported of the clogging of the concaves of threshing machines with "dust and mashed worms." John B. Smith, State Entomologist of New Jersey, expressed the opinion that in 1892 damage was much more severe and general than ever before.

Several entomologists who attended the World's Columbian Exposition at Chicago in 1893 discovered that the wheat moth was common in the grain exhibits. In October it was reported that "everything was ruined by the insect" and in the New Jersey exhibit every jar of grain was heavily infested. The whole Palace of Agriculture "had become one vast breeding ground of these insects" and orders were given that the grain be destroyed to prevent introduction of the moth into new localities.

In 1900 John B. Smith stated that the severe outbreak of that year resulted in a loss in New Jersey of $500,000 at a conservative estimate. He was the first to recommend a spring clean-up on farms of unthreshed wheat, chaff, imperfectly threshed straw, and all scattered, uncovered, or unsacked grain. In the fall of 1900 Smith reported that much grain harvested the previous July was not worth threshing; considerable wheat was useless for milling and there were instances of grain being unfit even for stock feed. Some millers refused to purchase wheat, and in Smith's opinion the wheat moth that

year "eclipsed all previous performances." As reported by L. O. Howard, clouds of moths choked the threshermen near Media, Pennsylvania, in November, 1900. In one case 600 bushels of grain shipped to Philadelphia was so badly heated the next day "that a man walked on top of it without making an impression with his shoe soles." During the exceptionally hot summer and fall of that year severe damage extended even so far northeast as central Long Island.

Prior to 1905 there had been several reports of extensive damage to corn in Texas, and in that year the moth was rated as "now exceedingly destructive to corn and wheat in some portions of Texas." Shocks of wheat were found to be "fairly alive" with the moths, and when the cap sheaves were lifted from the shocks "the little flies would rise in a cloud." There were cases where fifteen bushels of wheat were grown per acre and but ten recovered at threshing time. Some farmers, seeing the "hordes of grayish moths in the wheat," concluded that they laid eggs which produced cotton boll weevils!

An outbreak occurred in most parts of the eastern wheat region (southeastern Pennsylvania, New Jersey, Delaware, Maryland, Virginia, and western North Carolina) in 1908. T. B. Symons, in discussing the losses experienced by Maryland farmers, pointed out that a small average percentage of loss to a crop so widely grown as wheat causes a larger aggregate loss than a greater degree of damage to a less common crop.

G. A. Dean (1909) asserted that this insect was then the most serious pest of corn stored in cribs on Kansas farms. Michigan was invaded in the early nineties (R. H. Pettit, 1910). By the year 1913 (M. H. Swenk) the wheat moth had gained a fairly wide distribution over southeastern Nebraska. The annual loss in Pennsylvania was estimated by J. G. Sanders (1919) at over $1,000,000. The date of its establishment in California was given by E. O. Essig (1910) as 1902. Comparatively little trouble from the insect has been experienced so far north as Minnesota or west of the 100th meridian.

The first comprehensive investigation of the life history of *Sitotroga cerea'ella* in the United States was that made in Pennsylvania in 1917 by J. L. King. He found that the insect survived the winter as one-half to full-grown larvae, and discovered that the newly-hatched larvae are able to attack the developing wheat kernel even before it is pollinated.

The status of the species as a pest of corn in the Gulf Coast States was considered by E. A. Back (1919), who set forth that in many sections it is the most destructive insect in stored corn. An inclusive bulletin by the same author (1920) contained the observation that serious field infestation of corn so far north as Maryland is rare, but that in the Gulf States, in areas where the land is poor, shuck development is likewise poorest, giving insufficient protection to the ripening ears against moth attack. Moths emerging from corn on the cob frequently do so near the point of attachment of the kernels and are unable to escape from the tightly packed grain. Mature larvae sometimes provide an exit for the adult by boring through as many as eight or nine thicknesses of shuck covering.

The wheat moth has stimulated several interesting investigations and experiments in the United States. The problem of securing by selection new strains of corn characterized by a long protective shuck has received attention from C. H. Kyle (1918). Kyle pointed out that the loss of only one kernel for each ear of corn grown in this country annually would amount to a loss of at least 5,000,000 bushels. In attempting to eliminate the wheat moth from infested corn J. J. Davis (1921) experimented with paradichlorobenzene. An unexpected aftermath was that the flesh of chickens fed upon the fumigated grain was tainted "to such an extent as to make it distasteful and inedible." Protection of seed wheat against this species and other stored-grain insects was found by W. W. Mackie (1925) to be brought about by the use of copper carbonate dust; J. L. Horsfall (1928) determined the same to be true in the case of certain dust mixtures containing organic mercury compounds; and T. J. Headlee (1922) made use of the wheat moth in the course of successful tests with Milltown ball clay for the protection of grain.

Outbreaks of the wheat moth again arose in the eastern wheat region in 1921, 1922, and 1923. The loss in Virginia in 1922 was estimated by W. J. Schoene (1924) at between $500,000 and $1,000,000. In Prince William County "the weevil was so bad in some cases it was nearly impossible to get men to work at the machine." "It is probable," he wrote (1926), "that this insect causes greater loss to farmers of the State than any other one pest." Beginning in 1919, one of the most determined campaigns ever made to reduce the depredations

of the insect over a large area was prosecuted in Pennsylvania under the direction of C. H. Hadley, H. E. Hodgkiss, and others. It was estimated that the wheat crop in the southeastern counties of that State was reduced by at least 5,000,000 bushels in 1922 and that nearly as much damage was done in 1923.

The history of the moth in the United States promises that outbreaks may be expected to occur again in the region east of the Alleghanies, from Pennsylvania southward. Little change in the widespread culture and storage of wheat and corn, so favorable to the insect, may be expected there in the near future, and wheat growers will again be caught off guard, perhaps after the outbreaks of recent years have been nearly forgotten. Its irregularity is the wheat moth's salvation. Had our insect-embattled farmers found it on the firing line every year, they would have learned the art of warfare with it long ago.

VII. EPILOGUE.

Beginning in 1926, and originating in the town of Saticoy, California, there has developed a new phase of the long association between man and *Sitotroga cerealella*. On account of the activities of the codling moth (*Carpocapsa pomonella* Linn.) in walnut orchards it became desirable to rear large numbers of *Trichogramma minutum* Riley, a parasite which develops within the eggs of many species of moths. Stanley E. Flanders worked on the problem and soon developed a method for producing millions of the parasites from eggs of the Angoumois grain moth. Equipped with a small insectary and about five tons of corn he secured a maximum output of 600,000 moth eggs per day.

The success that attended Flander's investigation commended his method to other entomologists, and the moth soon became *persona grata* in various parts of the world. It has already contributed to control operations against the sugarcane borer in Louisiana, Mexico, and Barbados; the European corn borer in eastern Canada and the United States; the codling moth in Australia, South Africa, and the United States; the tea tortrix in Ceylon; the pecan case bearer in Texas; the Oriental fruit moth in Pennsylvania; the cranberry fruit worm in Massachusetts; the celery leaf tier in Florida; the orange tortrix in California; and the corn ear worm in Idaho.

REVISION OF THE PLEUROSTICT SCARABAEIDAE OF CUBA AND ISLE OF PINES.

II. RUTELINAE, DYNASTINAE, AND CETONIINAE.

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The pleurostict Scarabaeidae known to occur on the island of Cuba and on the Isle of Pines belong to the following subfamilies: Melolonthinae, Rutelinae, Dynastinae, and Cetoniinae. The subfamily Melolonthinae, which has been reviewed in a previous paper,[1] is the most numerous in point of species of any of the subfamilies. The Dynastinae, though richer in genera, are second in number of species, while the Rutelinae and Cetoniinae are very scantily represented in the fauna.

There has been some difficulty in assembling adequate series of the various species and it is largely through the kindness of Messrs. Bruner, Christenson, Mutchler, and Van Dine that the writer has been able to examine specimens of all but one of the described species. He expresses his sincere thanks to these gentlemen for their kindly cooperation. As with the paper on Melolonthinae, a part of the expense of publication has been borne by the Cuban Sugar Club, to which organization the writer extends thanks.

The subfamilies dealt with in this paper may be separated in the following manner:

1. Labrum membranous, retracted, not normally visible..... 2
   Labrum chitinous, exserted, normally visible; tarsal claws dissimilar, the anterior claw of each tarsus larger and stronger than the posterior, (Page 283).....**RUTELINAE**
2. Mandibles chitinous, visible at the sides of the head; claws of anterior tarsus of male often dissimilar; sides of mesothorax concealed from above (Page 285).....**DYNASTINAE**
   Mandibles in great part membranous, invisible without dissection; claws of all tarsi similar in both sexes; sides of mesothorax visible from above (Page 308).....**CETONIINAE**

[1]Chapin, 1932, Ann. Ent. Soc. Amer., Vol. XXV, pp. 173–209, Pls. I–III.

Subfamily **RUTELINAE.**

Of the two genera of this subfamily which are found in the region under discussion, one belongs in the Rutelini, the other in the Anomalini. The tribal characteristics are combined with the generic in the table given below:

1. Elytra without a membranous margin; clypeofrontal suture incomplete; large claw of all tarsi not split; integument highly polished with brilliant metallic luster (Page 283)..... **Rutela**
   Elytra with a membranous margin; clypeofrontal suture complete; large claw on anterior and middle tarsi split; integument neither highly polished nor with metallic luster (Page 284)..... **Anomala**

Rutela Latreille.

LATREILLE, 1802, Hist. Nat. Crust. Ins., Vol. 3, p. 151.

A single species of this genus is known to occur on Cuba; the same species also occurs on the adjacent mainland of North America.

1. **Rutela formosa** Burmeister.

(Plate VI, Fig. 60.)

Rutela formosa Burm., 1844, Handb. Ent., Vol. 4, Pt. 1, p. 383; Chevrolat, 1865, Ann. Soc. Ent. France, Ser. 4, Vol. 5, p. 29.

Of moderate size, subdepressed, color variegated ochreous yellow and piceous, the dark portions with strong greenish metallic luster, tibiae and tarsi metallic rose-red. Head nearly flat, most of clypeus and median vertical line yellow, shining, very finely and rather sparsely punctured. Clypeus with sides straight and strongly converging, anterior margin in male shallowly, in female more deeply, emarginate, anterior and lateral margins narrowly but acutely reflexed. Pronotum transverse, impunctate, anterior margin semicircularly excavated to receive head, basal margin biangulate, forming a short transverse section before the scutellum and two longer oblique lateral sections between the basal angles of the pronotum and the basal angles of the scutellum; sides and most of anterior margin strongly beaded, anterior and basal angles subacute. Color of disc dark, lateral and basal margins rather broadly yellow; discal spot, median line, two symmetrically placed spots on anterior margin, and two short subbasal oblique lines yellow. The yellow lateral margins each carrying a small dark spot near the middle. Scutellum ogival, impunctate, yellow with lateral margins broadly dark. Elytra impunctate, without trace of costae; yellow, with suture, two discal lines which are incomplete at base, a short lateral line in posterior half, an irregular spot on humeri, and lateral margins, dark. Pygidium impunctate, polished, with apex broadly rounded in male; rather coarsely sculptured laterally, with apex narrowly produced in female. Femora dark, broadly margined with yellow, anterior tibiae acutely tridentate, the teeth small and crowded into the apical fourth in male, the teeth larger and more widely separated

in female, claws on each tarsus strongly dissimilar in size but not in shape. Length, 13–16 mm.

Type locality.—"Cuba."

Type.—Probably at Halle.

Material examined: One male and one female from Los Palacios, Pinar del Rio, July 6, 1923, P. Betancourt; one female from Havana City, June 20, 1929, A. Bierig; one male from La Playa de Marianao, Havana, June 17, 1900, Palmer and Riley; one male and one female from near Havana City, May 3–13, 1905, M. T. Cook; three males and one female from Cayamas, Santa Clara, February 5–June 9, E. A. Schwarz; one male from Cienaga de Zapata, Santa Clara, July 9, 1920, S. C. Bruner; five males and five females from Jaronu, Camaguey, February 25–May 12, 1930, L. C. Scaramuzza (T. P. R. F. No. 3762); one female from Baragua, Camaguey, June 3, 1925, D. L. Van Dine (T. P. R. F. No. 1121); one male and one female from Santiago de Cuba, Oriente, W. Robinson; one male from Guantanamo, Oriente, May, 1910, C. T. Ramsden; and one male from "Cuba." The species has been reported from Nueva Gerona, Isle of Pines, by Holland[2] and is rather commonly found in southern Florida on the mainland.

Anomala Samouelle.

SAMOUELLE, 1819, Ent. useful Compend., p. 191.

A single species of this cosmopolitan genus has been recorded from Cuba. It appears, from the collections at hand, to be a fairly common species.

1. **Anomala calceata** Chevrolat.

(Plate VI, Fig. 57.)

Anomala calceata Chevr., 1865, Ann. Soc. Ent. France, Ser. 4, Vol. 5, p. 28.

Robust, slightly broader behind; yellowish brown, with disc of pronotum, scutellum, elytral humeri and suture, extremities of tibiae, and tarsi piceous to almost piceous-black. Head sparsely, rather finely but quite deeply punctured on vertex, more coarsely, densely, and confluently punctured on frons and clypeus; clypeus transverse, angles rounded, margin abruptly but rather narrowly reflexed. Antennal club longer than stem in both sexes. Pronotum very finely and sparsely punctured on disc, more coarsely so laterally, marginal bead fine on lateral, wider on anterior and basal, margins, anterior angles produced, basal angles obtuse and rounded. Scutellum finely and densely

[2]Holland, 1917, Ann. Carnegie Museum, Pittsburgh, Pa., Vol. 11, p. 339.

punctured except along sides and apex. Elytra with faint indications of one subhumeral and two discal costae, the sutural bead and costae bounded by rows of fine, closely set punctures, the intervals sparsely and irregularly punctured. Epipleura broad at humerus, rapidly narrowed behind. Pygidium moderately sparsely set with fine, transverse punctures, these becoming rounder at sides and apex. Metathorax clothed with long silky hair, rather finely and densely punctured, posterior coxal plates more coarsely, abdominal sternites much more sparsely, punctured. Anterior tibiae bidentate, the apical tooth rather long, broad, and curved. Upper portion of greater claw of anterior tarsus shorter and thinner than lower portion. Length, 10–13 mm.

Type locality.—"Cuba."

Type.—Location unknown.

Material examined: Two males from in or near Pinar del Rio City, Palmer and Riley; one male from Cabanas, Pinar del Rio, May 16, Palmer and Riley; four males and one female from Santiago de las Vegas, Havana, May 28–31, B. T. Barreto; two males from Alquizar, Havana, June 8, 1927, L. C. Scaramuzza (T. P. R. F. No. 3094); one male and two females from near Havana City, May 13–31, 1905, M. T. Cook; thirteen males and four females from Cayamas, Santa Clara, May 6–25, E. A. Schwarz; one male from Trinidad, Santa Clara, April–May, 1912, J. F. Merrill; one male from Constancia, Santa Clara, May, 1914, J. F. Merrill; three males and eight females from Baragua, Camaguey, various dates, Christenson, Scaramuzza, and Van Dine (T. P. R. F. Nos. 1060, 3063, and 5342); one female from Camaguey City, J. Acuna; one male from Jaronu, Camaguey, May 16, 1930, L. C. Scaramuzza; and one female from Vertientes, Camaguey, April 2, 1930, L. C. Scaramuzza.

Subfamily **DYNASTINAE.**

Although comprising fewer species than the Melolonthinae, the Cuban Dynastinae show a much greater diversity of structure, and a comparatively large number of genera. Some of the species are certainly indigenous; many, however, appear to be introductions from the mainland.

Considered from a world standpoint, this subfamily does not break up into well defined tribes, owing to the existence of many intergrading forms. For this reason, the key to tribes as given below may or may not accommodate material from other localities; it is based solely on Cuban species and is, the writer believes, satisfactory for this fauna.

1. Posterior tibiae truncate at apices and each fringed with a row of spinules... 2
   Posterior tibiae not abruptly truncate, the apices more or less concave within, each with the irregular margin produced either in a single spinous process or in two or three broad triangular processes..... 3
2. Outer margin of mandible even, not lobed or toothed; anterior tarsi of sexes always dissimilar, usually profoundly distorted in the males (Page 286)..... **Cyclocephalini**
   Outer margin of mandible trilobed; anterior tarsi of sexes always similar and normal in form (Page 296)..... **Pentadontini**
3. Anterior margin of pronotum with a thin membranous border; basal segment of hind tarsus without prominent spinose outer apical angle (Page 299)..... **Oryctini**
   Anterior margin of pronotum without membranous border; basal segment of hind tarsus prolonged in a long spine at the outer apical angle (Page 304)..... **Phileurini**

Tribe **Cyclocephalini.**

Two genera representing this tribe are known to inhabit Cuba; a third genus, *Parachalepus* Casey, one of whose species is common in Porto Rico, may eventually be found here.

1. Mandible thin and narrow, more or less truncate at the depressed apex; clypeus arcuate or parabolic (Page 286)..... **Cyclocephala**
   Mandible thick and curved, the upper angle of the compressed apex usually acute; clypeus trapezoidal; color uniform piceous or black (Page 292), **Dyscinetus**

Cyclocephala Latreille.

LATREILLE, 1829, in Cuvier, Regne Animal, Vol. 4, p. 552.

This genus is a large and unwieldy one comprising many species from the western hemisphere. Six certain and one doubtful species are known to inhabit Cuba and the Isle of Pines, one of which appears to be the most common of all the Scarabaeidae of the region.

In the key which follows, no attempt has been made to include *C. frontalis* Chevr., 1829,[3] as the characters given by the author for its identification are trivial and apply fairly well to many specimens of *C. cubana* n. sp. Since Chevrolat treats the species as distinct from "*C. signata* Fabr." of Cuba (*C. cubana* of this paper), and since the dimensions given by Chevrolat indicate a larger species, the writer holds the name as that of a species at present not recognized. The type of *C. frontalis* had been destroyed before 1865, according to Chevrolat.

1. Pronotum black or broadly marked with piceous..... 2
   Pronotum pale, immaculate or rarely with two small round piceous spots on anterior margin; great claw of anterior male tarsus cleft, the inner ramus fine or very fine, acicular..... 5

[3]Chevrolat in Guerin, 1829, Incon. Regne Animal, Ins., p. 90.

2. (Male unknown); size small (9–10 mm.); pronotum pale with two broad, nearly rectangular spots on the basal half; elytra pale, with suture and sometimes a spot on lateral margin slightly darker; pygidium conical, acuminate (Page 287) ..... **fusiformis**
(Male known); size larger (12 mm. or more); body form compact; pygidium normal 3
3. Greater claw of anterior tarsus of male without indication of cleft 4
Greater claw of anterior tarsus of male cleft as in *C. verticalis* Burm.; elytra pale, each with a dark subsutural longitudinal line and two dark transverse, zig-zag lines, one subhumeral, the other anteapical (Page 288) ..... **notata**
4. Antennal club of male hardly longer than stem; pronotum pale, with two longitudinal discal piceous vittae whose inner margins are straight and outer margins coarsely tridentate; elytra pale, each with a longitudinal piceous stripe which may be complete or divided near the middle, extending from humerus to near apical sutural angle (Page 289) .. **signatoides**
Antennal club of male a little more than twice as long as stem; pronotum entirely glossy black, elytra either all black or with a pale circumscutellar spot (Page 289) ..... **atricolor**
5. Size large (15 mm. or more); antennal club of male about as long as last segment of maxillary palpus; basal margin of pronotum obsolete (Page 290) ..... **verticalis**
Size smaller (14 mm. or less); antennal club of male half again as long as last segment of maxillary palpus; basal margin of pronotum complete (Page 291) ..... **cubana**

1. **Cyclocephala fusiformis** n. sp.

Elliptical with pointed extremities, somewhat of the build of *C. vincentiae* Arr.; yellowish brown, the basal two-thirds of the pronotum bearing two nearly quadrate piceous spots, the elytral suture and sometimes a small ill-defined area on the lateral margin dark. Head finely and rather sparsely punctured on frons, finely and more densely so on clypeus, which is parabolic, with lateral and apical margins evenly reflexed. Pronotum transverse, sides broadly and evenly rounded, anterior angles produced and acute, basal angles obliterated, marginal bead entire, surface shining, sparsely and finely punctured. The piceous spots separated by an interval equal in width to the scutellum, their inner and basal margins straight, outer margins strongly bisinuate, apical margin concave. Scutellum with a few fine to very fine punctures. Elytra, except extreme apices, shining, more coarsely punctured than pronotum, sutural bead slightly elevated, lateral margin even, not notched near apical third, humeri and lateral fourths near middle strongly tumid. Sides of metasternum rather finely and densely punctured, middle portion and posterior coxal plates impunctate, abdominal sternites laterally very finely and not densely punctured, each with a single row of setigerous punctures, middle portion of abdomen impunctate. Anterior tibiae tridentate, upper tooth small but distinct. Length, 10 mm.

Type locality.—Santa Barbara, Isle of Pines.

Type and paratype.—U. S. N. M. Cat. No. 43895.

Material examined: Two females from the above locality, collected March 15, 1923, by S. C. Bruner.

2. **Cyclocephala notata** (Illiger).

Melolontha notata Illiger, 1805, Mag. Insekt., Vol. 5, p. 236 (=*Melolontha signata* Oliv. nec Fab., renamed).
Cyclocephala notata Burm., 1847, Handb. Ent., Vol. 5, p. 55.

Of medium size, oval, slightly wider behind; pale testaceous, with frons, vertex, two irregular spots on pronotum, and a pattern of delicately traced lines on elytra piceous. Head above the sharply angulated clypeofrontal suture finely and quite sparsely punctured, frons a little more coarsely and more densely punctured, lateral margins narrowly, apical margin more strongly, reflexed. Male antenna with club large and heavily built, more than twice as long as stem, that of female similar but slightly smaller. Pronotum about half again as wide as long, sides parallel in basal half, anterior angles acute, basal angles broadly rounded, marginal bead complete. Surface finely and very sparsely punctured; disc, on either side of the median line, with an irregular piceous spot reaching from base to apex, the inner margin of which is straight, the outer roughly tricuspidate. Scutellum ogival, impunctate. Elytra with faint indications of discal costae, the broad interspaces coarsely and rather densely punctured. The completely developed elytral pattern as follows: a longitudinal line, usually the heaviest of the markings, commencing at base just inside humeral callus and proceeding parallel to side margin of scutellum to near suture where it follows the first broad interspace nearly to apex of elytron; a transverse zig-zag line just behind the humeral callus and a second and similar line in about apical fourth. Pygidium finely granulate, sparsely set with setigerous punctures. Underparts shining, median portion sparsely and finely, the lateral portions more coarsely and densely, punctured. Anterior tibiae tridentate in either sex. Anterior male tarsus strongly inflated, greater claw cleft near apex, the inner part very fine, aciculate. Oedeagus similar to that of *C. cubana*. Length, 11–13.5 mm.

Type locality.—? (assumed as Santo Domingo by Burmeister).

Type.—Location unknown.

Material examined: Many specimens from several localities in Haiti and Republica Dominicana, and a single male taken at Guantanamo, Oriente, at light, November 28, 1931, by L. C. Scaramuzza (E. E. A. de Cuba, No. 9730).

This species has probably been recently imported into Cuba from Santo Domingo. Burmeister placed *C. notata* in his section *heterocerae*, overlooking the fact that the antennal clubs of both sexes, and not merely that of the male, are enlarged. In fact, the comparative sizes of the clubs in the sexes is about the same as in *C. cubana* and notwithstanding a very different appearance, the two species are quite closely related. This is further borne out by the similarity of the oedeagi.

3. **Cyclocephala signatoides** n. sp.

(Plate IV, Fig. 47.)

Form, size, and general appearance of *C. signata* Fabr. Head pale with vertex piceous, finely, sparsely, and evenly punctured, except near the strongly reflexed margin of the clypeus, where the punctures are finer and very dense. Pronotum with two piceous spots which extend almost its length and are similar in shape to those in *C. fusiformis*, shining, finely and very sparsely punctured, sides strongly arcuate in anterior two-thirds, nearly parallel in basal third, anterior angles acute and produced, basal angles rounded but distinct, marginal bead complete. Scutellum longer than wide, finely and sparsely punctured. Elytra alutaceous and dull in male, shining in female, each with two ill-defined oblique piceous stripes, the inner extending from near the scutellum to the sutural margin at middle of length, the other and greater, from near humeral callus to near apical sutural angle. Surface sparsely punctured, very finely so in male, more coarsely so in female, sutural bead slightly elevated, lateral margin of elytra of female not notched near apical fourth. Pygidium broadly triangular and strongly convex in male, more elongate, less convex, and with a depression on either side of apex in female, surface very finely granulate and sparsely set with setigerous punctures. Anterior tibiae of male strongly bidentate, with a very weak tooth above, that of female tridentate. Greater claw of anterior tarsus of male undivided, slightly shorter than claw segment of tarsus, lesser claw about half as long as greater. Length, 11 mm.

Type locality.—San Juan y Martinez, Pinar del Rio.

Type and paratype.—U. S. N. M. Cat. No. 43896.

Material examined: A male, the type, from the above locality, collected as a pupa and reared by P. Cardin; a female from San Blas, Pinar del Rio, 1918, W. M. Mann.

This species superficially resembles *C. signata* Fabr., a Jamaican species, but may be separated from that species by the undivided greater claw of male, by the proportionately longer antennal club, and by the much finer and sparser punctation of the pronotum in either sex.

4. **Cyclocephala atricolor** n. sp.

(Plate IV, Fig. 50.)

Form and size of *C. signata* Fabr., body uniform black or with a reddish-yellow circumscutellar spot on the elytra, legs black or dark castaneous. Head finely punctured, the punctures sparse on frons and vertex, more dense on clypeus and, near the reflexed margin, very dense. Pronotum with sides evenly arcuate, anterior angles produced and acute, basal angles broadly rounded, marginal bead complete, surface shining, disc more finely and sparsely punctured than frons, the

punctures toward the posterior angles becoming coarser. Scutellum about as wide as long, finely and sparsely punctured. Elytra of male alutaceous and dull, those of female shining, very finely punctured except near scutellum, sutural bead slightly elevated, lateral margin in female not notched near apical fourth, the humeral calli and areas near lateral margins at middle of length somewhat tumid. Pygidium of each sex as in the corresponding sex of *C. signatoides*, but with the setigerous punctures more densely placed in male and without lateral depressions in female. Lateral portions of metasternum rather finely and densely punctured, middle portion shining and set off from lateral portions by small patches of coarse punctures. Posterior coxal plates very finely and sparsely punctured, abdominal sternites finely and densely punctured laterally, each with a single complete transverse row of coarse setigerous punctures. Anterior tibiae of male strongly bidentate, a third tooth indicated, that of female distinctly tridentate. Greater claw of male anterior tarsus not divided, the lesser claw almost as long as the greater. Length, 10–12 mm.

Type locality.—Baragua, Camaguey.

Type and paratypes.—U. S. N. M. Cat. No. 43897.

Material examined: Twenty-two males and two females from the above locality, taken at light, the males between May 17 and June 28, the females on July 5 and August 9, L. C. Scaramuzza.

A single male from Baracoa, Oriente, April 19, 1916, P. Cardin, appears to be this species. It has not attained full coloration.

5. **Cyclocephala verticalis** Burmeister.

(Plate IV, Fig. 49.)

Cyclocephala verticalis Burm., 1847, Handb. Ent., Vol. 5, p. 51; Chevrolat, 1865, Ann. Soc. Ent. France, Ser. 4, Vol. 5, p. 31.

Cyclocephala sanguinicollis var. *verticalis* Leng and Mutchler, 1914, Bull. Amer. Mus. Nat. Hist., Vol. 33, p. 441.

Above medium size for genus, robust, nearly uniform reddish-testaceous, head and leg joints dark. Head above the strongly biarcuate clypeofrontal suture sparsely, finely, and irregularly punctured, clypeus densely and more coarsely punctured, anterior clypeal margin thicker and more strongly reflexed than lateral, mandibles, when not worn, rather strongly hooked at outer apical angle. Pronotum with sides broadly and evenly arcuate, anterior angles acute and hardly produced, basal angles effaced, marginal bead fine and complete except at very middle of base, sparsely and irregularly punctured, the punctures very fine on disc, slightly coarser on flanks. Scutellum with a few punctures at base. Elytra sparsely and finely punctured, sutural marginal bead not elevated except in apical fifth, lateral margin in female not notched near apical fourth. Pygidium of male convex, rounded apically, finely and sparsely punctured, that of female less convex and more acute

apically. Metathorax and posterior coxal plates finely, the latter sparsely, punctured except for middle portion of metasternum, which is impunctate. Abdominal sternites each with a single transverse row of coarse setigerous punctures, the sides of the sternites finely and rather densely punctured. Anterior tibiae tridentate in both sexes, greater claw of anterior tarsus of male cleft, lesser claw about half as long as greater. Length, 15–16.5 mm.

Type locality.—"Cuba."

Type.—Probably at Halle.

Material examined: One female from 7 kilometers north of Vinales, Pinar del Rio, September 16–22, 1913; one female from San Diego de los Banos, Pinar del Rio, April 17, 1900, Palmer and Riley; two males and one female from San Blas, Santa Clara, August, 1930, G. C. Rowe (E. E. A. de Cuba, No. 9392); and one female from Galbis, Camaguey, July 16, 1919, Zoe McLaughlin.

6. **Cyclocephala cubana** n. sp.

(Plate IV, Fig. 48.)

Cyclocephala signata auct. nec Fabr. (pars).

Of medium size, pale reddish-brown or yellowish-brown, vertex, joints of legs, and usually four spots on elytra dark. Head with frons slightly concave, coarsely and sparsely punctured, clypeofrontal suture biarcuate, clypeus more finely and very densely punctured in male, rugosely punctured in female, margin of clypeus reflexed, rather more so anteriorly than laterally. Pronotum subangulately arcuate at sides, anterior angles subacute but finely rounded at apices, basal angles effaced, marginal bead complete. Surface coarsely, shallowly, sparsely, and irregularly punctured, the punctures finer and denser at sides. Color usually entirely pale but occasionally with two small round spots on anterior margin. Scutellum with a few scattered punctures. Elytra with faint indications of two discal costae, and with the sutural marginal bead not elevated in basal two-thirds, rather coarsely punctured on disc, more finely so at sides. When fully colored, each elytron with an elongate spot behind the humeral callus and a larger, irregular spot at middle of width at apical fourth. Lateral margin of elytra in female without notch but with a slight thickening near apical fourth. Pygidium of male convex, finely rugulose, sparsely set with setigerous punctures, that of female less convex, shining, discretely punctured except along basal margin. Anterior half of metasternum densely and finely punctured, posterior half with a few setigerous punctures, posterior coxal plates very finely rugulose, abdominal sternites finely rugulose basally, shining apically, each with a single transverse row of setigerous punctures. Anterior tibia of male bidentate, with a third tooth indicated, that of female tridentate. Greater claw of anterior tarsus of male cleft, lesser claw about two-thirds as long as greater. Length, 12–14 mm.

Type locality.—Baragua, Camaguey.

Type and paratypes.—U. S. N. M. Cat. No. 43898.

Material examined: Type, a male, and 358 male and 51 female paratypes from Baragua, Camaguey, various dates, mostly at light, Plank, Scaramuzza, Stahl, and Van Dine, (T. P. R. F. Nos. 914, 1034, 1040, 1057, 1059, 1073, 2462-D, 2462-F, and 3061).

In addition, nearly 200 specimens from the following localities have been studied: Pinar del Rio—Cabanas and Mariel; Havana—Alquizar, Havana, Hoya Colorado, San Antonio de los Banos, and Santiago de las Vegas; Santa Clara—Banos de Ciego Montera, Cayamas, Constancia, Soledad, and Trinidad; Camaguey—Jaronu, Jatibonico, and Vertientes; Oriente—Jobabo (T. P. R. F. No. 135) and Santiago de Cuba; and "Cuba."

This species is quite distinct from *C. signata* Fabr. though the two have been confused for many years. The most evident differences between the two species lie in the male genitalia, in the antennae, and in the lateral margins of the elytra of the females. The oedeagi are different in conformation, that of *C. signata* somewhat of the type of *C. atricolor*. In the present species, the antennal club is notably longer than the stem in the male, and a little longer than the stem in the female. In *C. signata* the antennal clubs of the two sexes are similar and only a little longer than the respective stems. The lateral margin of an elytron in the female is regular with a narrow marginal bead which gradually disappears at apical fourth in *C. signata* while in *C. cubana* the marginal bead ends at apical fourth in a slight tumidity, though there is no definite notch as in some species of the genus.

Dyscinetus Harold.

Chalepus MacLeay, 1819, Horae Ent., Vol. 1, p. 149 (nec *Chalepus* Thunberg, 1805).
Dyscinetus Harold, 1869, Col. Hefte, Vol. 5, p. 123.
Palechus Casey, 1915, Mem. Coleopt., Vol. 6, p. 174.

Three species of this genus are represented in the Cuban collections before the writer, all of which may be referred to previously described species. One of the species, *D. picipes* (Burm.), shows great variation in the strength of the pronotal and elytral punctation, leading in the direction of a polished, impunctate form (=*D. obsoletus* (Lec.)). As yet, no specimen of this last-mentioned form has been seen from Cuba, but a

series from Porto Rico is at hand which exhibits, to a nice degree, the intergrades between the two types.

Dyscinetus trachypygus (Burm.) has been reported from Cuba and may occur there, but no specimen from the island has yet been seen by the writer. It is omitted from the key because it seems fairly certain that the reports are based on a closely related species, *D. laevipunctatus* Bates, Cuban specimens of which are at hand.

The subgenus *Palechus* Casey appears of doubtful value to the writer. It is based on *D. laevipunctatus* Bates, *D. dubius* Oliv., and *D. histrio* Casey. The last named is the originally designated genotype; it, however, appears to be the same as *D. laevipunctatus*. In these species the structure of the anterior tarsi of the males is similar and much simpler than in such species as *D. trachypygus* Burm., and it was on the basis of the comparatively simple anterior male tarsi that Casey erected the genus. On the other hand, a study of the oedeagus, which the writer believes gives a surer index of relationships, shows that *D. laevipunctatus* is very closely related to *D. trachypygus*, while *D. dubius* must be associated, though not particularly closely, with *D. frater* Bates.

1. Punctures of frons no coarser than those of clypeus; clypeus strongly rugulose; larger claw of anterior tarsus of male long and stout, as long as the ultimate tarsal segment; penultimate tarsal segment with striated area on inner face; pygidium shining, coarsely punctured (Page 293)... **picipes**
   Frons much more coarsely punctured than clypeus, which is either without sculpture other than punctures or is finely rugulose in the anterior angles only; pygidium, at least in part, scabriculate..... 2
2. Clypeus finely rugulose in anterior angles; pronotum coarsely and rather densely punctured; larger claw of anterior tarsus of male stout, about half as long as ultimate tarsal segment, penultimate and last segments with striated areas on inner faces (Page 295)..... **frater**
   Clypeus not at all rugulose; pronotum moderately finely and sparsely punctured; larger claw of anterior male tarsus not much stouter than smaller claw, about half as long as the not greatly thickened ultimate segment and split for half its length into two nearly equal parts, inner faces of tarsal segments without striated areas (Page 295)... **laevipunctatus**

1. **Dyscinetus picipes** (Burmeister).

(Plate V, Fig. 54.)

Chalepus picipes, Burm., 1847, Handb. Ent., Vol. 5, p. 79; Chevrolat, 1865, Ann. Soc. Ent. France, Ser. 4, Vol. 5, p. 31.
Dyscinetus picipes, Bates, 1888, Biol. Centr.-Amer., Vol. 2, Pt. 2, p. 312.
Dyscinetus puncticauda Casey, 1909, Can. Ent., Vol. 41, p. 282.
Dyscinetus ebeninus Casey, 1915, Mem. Coleopt., Vol. 6, p. 169.
Dyscinetus subquadratus Casey, 1915, l. c., p. 166.

Of medium size, oval, slightly depressed, body uniform piceous, legs and underparts with a reddish tinge. Head broad, frons with a few rather fine punctures near middle, otherwise impunctate, clypeus strongly, transversely rugulose, side margins straight and heavy,

anterior margin strongly arcuate and reflexed. Pronotum transverse, sides evenly curved, sparsely punctured, the punctures coarser laterally, lateral margins entire, anterior margin narrowly broken across disc, posterior margin wanting. Scutellum virtually impunctate. Elytra without elevated costae, but with paired rows of punctures, interspaces between members of pairs impunctate, interspaces between pairs sparsely set with simple punctures; sutural bead elevated for a short distance near apex, lateral bead strong except across apex. Pygidium not at all scabriculate, coarsely and moderately densely ocellate-punctate, surface between punctures shining. Underparts impunctate medianly, coarsely and rather sparsely punctured laterally. Anterior tarsus of male rather stout, penultimate segment with a strongly striated area occupying at least half of under surface of segment, last segment stout, equal in length to the three preceding segments combined, without striated area on under side. Inner (larger) claw greatly swollen, abruptly twisted and bent, split apically for about one-third length, the lower part much stouter than upper. Anterior tarsus of female not enlarged, claws similar and equal. Length, 16–17.5 mm.

Type locality.—"Porto Rico."

Type.—Probably at Halle.

Material examined: One male and one female from seven kilometers north of Vinales, Pinar del Rio, September 16–22, 1913; one female from Havana City, Baker; four males and three females from near Havana City, May–June, 1905, M. T. Cook; thirteen males and three females from Cayamas, Santa Clara, January 16–February 28, May 7–June 1, E. A. Schwarz; one female from Trinidad, Santa Clara, April–May, 1912, J. F. Merrill; one female from Constancia, Santa Clara, May, 1914, J. F. Merrill; three males and five females from Banos de Ciego Montera, Santa Clara, March 1, 1918; six males and seven females from Baragua, Camaguey, May and October, Stahl, Scaramuzza, and Van Dine (T. P. R. F. Nos. 179, 204, 1107, and 3069); one female from Jaronu, Camaguey, May 14, 1926, B. T. Barreto; one female from Guantanamo, Oriente, June 3, 1910, C. T. Ramsden; and two females from Santiago de Cuba, Oriente.

This appears to be the most common of the Cuban species of *Dyscinetus*. It also occurs abundantly on Porto Rico and has been recorded from various other islands of the West Indies. A small series of specimens from several localities on continental America have been studied and no differences of specific importance have been found. Although the present paper is not intended to include a study of continental material, it seems best to indicate such synonymy as is evident after a study of the Casey and Museum collections.

2. **Dyscinetus frater** Bates.

(Plate V, Fig. 56.)

Dyscinetus frater Bates, 1888, Biol. Centr.-Amer., Vol. 2, Pt. 2, p. 312, Pl. 18, Fig. 13.
Dyscinetus picipes Holland, 1917, Ann. Carnegie Mus., Vol. 11, p. 340 (err. determ.).
Dyscinetus obtusus Casey, 1915, Mem. Coleopt., Vol. 6, p. 170.

Averaging slightly larger than *D. picipes* Burm., elytra inflated at sides near middle of length, color above uniform black, underparts and legs castaneous to piceous. Head, above the faintly indicated clypeofrontal suture, coarsely and sparsely punctured, frons sparsely, but much more finely, punctured, with anterior angles feebly and irregularly strigulose. Pronotum transverse, anterior angles acute, basal angles broadly rounded, sides feebly and evenly arcuate, lateral marginal bead complete, anterior bead well defined at sides but absent across disc. Surface coarsely, evenly, and not densely punctured. Scutellum with a few coarse punctures. Elytra less coarsely punctured than pronotum, with four double rows of fine ocellate punctures, the interspaces of the pairs very sparsely, the interspaces between the pairs more densely, punctured. Pygidium very densely and finely scabriculate, very sparsely setose. Underparts very coarsely and densely punctured at sides, virtually impunctate along median fourth of width. Anterior tibia with three stout and rather short teeth, anterior tarsus of male not greatly thickened, last segment long and stout, with a very small striated area near base, penultimate segment with a larger area of striation, large claw bent at right angle to claw segment, split in about apical third, the inner portion about half as thick as the outer. Length, 18–20 mm.

Type locality.—Mexico.

Type.—In the British Museum.

Material examined: One male from Nueva Gerona, Isle of Pines, June 1, 1912, Carnegie Museum donor; and two females from Trinidad, Santa Clara, April–May, 1912, J. F. Merrill.

The specimen from Nueva Gerona is one of the set reported as *D. picipes* Burm. by Holland and was afterward presented to the U. S. National Museum. In addition to the specimens mentioned above, larger series from Honduras, Costa Rica, and Panama have been studied.

3. **Dyscinetus laevipunctatus** Bates.

(Plate V, Fig. 55.)

Dyscinetus laevipunctatus Bates, 1888, Biol. Centr.-Amer., Vol. 2, Pt. 2, p. 311.
Dyscinetus (*Palechus*) *histrio* Casey, 1915, Mem. Coleopt., Vol. 6, p. 174.
Chalepus trachypygus Chevrolat, 1865, Ann. Soc. Ent. France, Ser. 4, Vol. 5, p. 31.

Similar in size to *D. frater* Bts., oval, slightly broader behind, black with legs dark castaneous. Head above the clypeofrontal suture sparsely and quite coarsely punctured on disc of frons, vertex

impunctate, clypeus finely and very sparsely punctured at sides, densely so at middle, surface not strigose. Pronotum transverse, anterior angles acute, basal angles rounded, sides nearly straight, marginal bead as in *D. frater* Bts., surface sparsely and more finely punctured than frons. Scutellum impunctate or with an incomplete submarginal row of fine punctures. Elytra with four double rows of fine punctures, the interspaces of each pair impunctate, the interspaces between pairs finely and rather densely punctured. Pygidium finely and densely scabriculate, somewhat as in *D. trachypygus* (Burm.) except that toward the apex the fine scabriculation gives way to a coarser vermiculation. Underparts rather coarsely and sparsely punctured at sides, impunctate medianly. Anterior tibia tridentate as in *D. frater* Bts., anterior tarsus of male not swollen, last segment long but without striated area on inner face, larger claw cleft to near middle of length, the portions nearly equal in stoutness. Length, 17–20 mm.

Type locality.—Central America, Mexico to Panama.

Type.—In the British Museum.

Material examined: One male from Nueva Gerona, Isle of Pines, September 8–10, 1928, Bruner and Boucle; one male from Santiago de las Vegas, Havana, P. Cardin; one male and one female from Cayamas, Santa Clara, May 7 and June 1, E. A. Schwarz; one male from Banos de Ciego Montera, Santa Clara, March 1, 1918; one male and one female from Jaronu, Camaguey, April 22 and May 4, 1930, L. C. Scaramuzza; one male from Chaparra, Oriente, February 18, 1914, G. N. Wolcott.

Many specimens from Mexico, Guatemala, Nicaragua, and Honduras have been studied in connection with the Cuban material mentioned above.

Tribe **Pentadontini.**

A single genus of Pentadontini occurs in the region under discussion. Both of the species found here are of wide distribution and may or may not be endemic. The tribe is, from a world standpoint, too closely related to the Oryctini to warrant separation.

Ligyrus Burmeister.

BURMEISTER, 1847, Handb. Ent., Vol. 5, p. 542.

A small genus of moderately sized, robust species, all of which are inhabitants of the New World. There appears to be considerable confusion here in the application of names. A case in point is the use of *juvencus* Fabr. *Scarabaeus juvencus* Fabr., 1775, was described as from Carolina. Burmeister

accepts the name for the Carolina species and notes on page 524 of his work cited above that the name probably applies to the same species as that described by DeGeer (1774) as *gibbosus*. Gemminger and Harold accept *juvencus* as from the continent but maintain it as a species distinct from *gibbosus*. Later the name *juvencus* was transferred to the species commonly found in the West Indies and so appears in the Leng-Mutchler catalog. Casey, in the sixth volume of his Memoirs on the Coleoptera (1915), returns to Burmeister's view and definitely assigns *juvencus* to *gibbosus*. For the West Indian species, recently known as *Ligyrus juvencus* (Fabr.), the name *Ligyrus fossor* (Latr.) will come into use, a study of a long series of specimens from northern South America and various West Indian islands failing to reveal any differences of specific import.

Two species of the genus are known to occur in Cuba, and their more obvious characteristics are indicated in the following dichotomy:

1. Pronotum coarsely punctured; color generally rufocastaneous; lateral lobes of oedeagus each with a long curved subbasal process (Page 297), **fossor**

   Pronotum finely punctured; color usually piceous; lateral lobes of oedeagus without processes near base (Page 298) ..... **tumulosus**

1. **Ligyrus fossor** (Latreille).

(Plate IV, Fig. 41.)

Scarabaeus fossor Latr., in Humboldt and Bonpland, 1832, Voy. aux reg. equinox. du nouv. cont., Part 2, Vol. 2, p. 11, Pl. 1, Fig. 2.
Podalgus fossor Burm., 1847, Handb. Ent., Vol. 5, p. 119.
Ligyrus fossor Burm., 1847, l. c., p. 542.
Ligyrus juvencus auct. nec Fabr. 1775 (pars).
Ligyrus (Ligyrellus) fossor Casey, 1915, Mem. Coleopt., Vol. 6, p. 206.

Of medium size, rather broad and robust, uniformly rufocastaneous. Head with vertex smooth, frons, above the transverse carina which marks the clypeofrontal suture, coarsely and rather closely punctured, clypeus trapezoidal, apex narrow, reflexed and bidentate, more finely punctured than frons. Pronotum similar in the two sexes, not tuberculate or excavate anteriorly, very convex, rather coarsely and sparsely punctured. Apical and lateral marginal beads entire, basal margin broken on either side of middle. Scutellum with a few rather fine punctures. Elytra punctate-striate, the punctures coarse, intervals mostly without punctures, latero-apical portion of each elytron more finely, quite densely and irregularly punctured. Sutural bead not differentiated from rest of elytron. Pygidium coarsely and not densely (male), or quite densely (female), punctured. Sides of metathorax and abdominal sternites densely, rest of underparts sparsely, punctured. Anterior tibia tridentate. Claws simple. Length, 15.5–17 mm.

Type locality.—South America.

Type.—Probably in Paris Museum of Natural History.

Material examined: Besides specimens from various localities in South America and from various islands in the West Indies, the following specimens from Cuba have been studied: One male from San Blas Martinez, Pinar del Rio, December 20, 1918, W. M. Mann; two females from Pinar del Rio City, March 29, 1900, Palmer and Riley; one female from San Diego de los Banos, Pinar del Rio, April, 1900, Palmer and Riley; one male from Santiago de las Vegas, Havana, July 12, 1910 (E. E. A. de Cuba, No. 7164); one female from Colon, Matanzas, January 18, 1930; three males and two females from Cayamas, Santa Clara, May 20–June 8, E. A. Schwarz; and one male and two females from "Cuba."

This species is the type of the subgenus *Ligyrellus* Casey.

2. **Ligyrus tumulosus** (Burmeister).

(Plate IV, Fig. 42.)

Heteronychus tumulosus Burm., 1847, Handb. Ent., Vol. 5, p. 101.
Ligyrus tumulosus Burm., 1847, l. c., p. 542.
Ligyrus (*Anagrylius*) *tumulosus* Casey, 1915, Mem. Coleopt., Vol. 6, p. 205.

Of medium size, elongate oval, uniformly piceous when mature. Head with vertex smooth, frons, above the transverse carina which is broken at middle, set with a mixture of very coarse and very fine punctures, clypeus trapezoidal, about half as broad at apex as at base, apical margin reflexed and produced at sides into blunt teeth, surface rather finely punctured and coarsely wrinkled. Pronotum convex, with a low and inconspicuous tubercle at middle of anterior margin, behind which is a small oval depression, surface rather finely and sparsely punctured except for a small patch of very fine and very densely set punctures in the depression, anterior and lateral marginal beads broad, base not margined. Scutellum almost impunctate. Elytra coarsely punctate-striate, the striae in close pairs, narrow intervals between members of each pair impunctate, broader intervals between pairs coarsely and irregularly punctured, apically and laterally finely and densely punctured. Pygidium coarsely and sparsely (very sparsely in male) punctured. Lateral portions of metathorax and abdominal sternites very densely sculptured, median portions almost impunctate. Anterior tibia tridentate, claws simple. Length, 18–19 mm.

Type locality.—"South Carolina and St. Domingo."

Type.—Probably at Halle.

Material examined: In addition to a specimen said to have come from Mexico and many specimens from various islands of the West Indies, the following Cuban specimens have been

studied. One male from Trinidad, Santa Clara, April–May, 1912, J. F. Merrill; one female from Jaronu, Camaguey, February 19, 1931, L. C. Scaramuzza (C. S. C. No. 4028); one female from Port Tanamo, Oriente, March 2, 1930, Parish and Pery; one female from San Nicolas, Oriente, July 20–21, 1927, S. C. Bruner; one female from Guantanamo, Oriente, July 20, 1914, C. T. Ramsden; and one female from Nueva Gerona, Isle of Pines, September 12, 1928, Bruner and Boucle.

This species is the type of the subgenus *Anagrylius* Casey. In a comprehensive work on the genus *Ligyrus*, some or all of the subgenera proposed by Casey might prove useful; for the present work the author has thought it preferable not to employ them.

Tribe **Oryctini.**

Very closely related to the preceding tribe, and it is only because of the evident lack of close relationship between *Ligyrus* and *Strategus* that both tribes are maintained here. Only the single genus *Strategus* of the Oryctini occurs in this region.

Strategus Kirby.

KIRBY, in Hope, 1837, Coleopt. Manual, Vol. 1, p. 87.

A genus of large to very large species, all of which are at home in the western hemisphere. The pronotum of the males of most species is armed with three horns, one at the middle of the anterior margin, the others on the sides of the disc slightly back of the middle. There are several groups of subgeneric rank in the genus, two of which are found in Cuba.

1. Pronotum (male) armed with three horns; galea of maxilla with six strong teeth (Page 299)..... **Strategus**
   Pronotum (male) armed with a single small tubercle at middle of anterior margin; galea of maxilla rounded at apex and with a single small tooth on inner margin remote from apex (Page 302)..... **Strategopsis**

Strategus s. str.

Two and possibly three species of typical *Strategus* are found in Cuba. *Strategus anachoreta* Burm. is common and widely distributed in the island and is an important enemy of the coconut palm. *S. ajax* (Oliv.) is also common and apparently breeds in certain species of *Agave*. *S. aloeus* L., a species whose normal range is northern South America, is represented in the Cuban material at hand by a single specimen labelled "Cuba" only. The species is included in the key which

follows, though the record should be considered as distinctly doubtful.

1. Elytra polished and shining; pronotum with areas of coarse sculpture..... 2
   Elytra finely alutaceous and dull; pronotum without coarsely sculptured areas; anterior pronotal horn usually distinctly bifid at extreme apex (Page 300)..... **ajax**
2. Coarse sculpture of pronotum confined to anterior half and to a very narrow band close to the lateral and posterior margins; lateral lobes of oedeagus slender, arcuate, and of equal width throughout (Page 301), **anachoreta**
   Coarse sculpture of pronotum more general, the posterior marginal band widened on either side of median line and often connected with the anterior area by two latero-median bands; lateral lobes of oedeagus stout, straight, and acuminate..... **aloeus***

1. **Strategus ajax** (Olivier).

(Plate V, Fig. 51.)

Scarabaeus ajax Oliv., 1789, Ent., Vol. 1, Pt. 3, p. 27, Pl. 2, Fig. 18.
Strategus titanus auct. nec Fabr. 1775 (pars).

Large to very large, robust, parallel, uniformly castaneous to piceous, vestiture of pygidium and underparts ferruginous, sparse. Head with vertex smooth and impunctate, frons with two coarsely punctured areas adjacent to eyes, tubercles on clypeofrontal suture distinct and widely separated; clypeus subtriangular, apex broadly reflexed, coarsely sculptured. Pronotum highly polished, sparsely and finely punctured. Anterior median horn, in its fullest development, about twice the length of head, gently curved upward toward apex, sides parallel or slightly convergent apically, never, as in *S. simson* L. (=*S. titanus* Fabr.), broadly divergent, apex with small notch, dorsal surface feebly channeled throughout length and usually with a faintly indicated longitudinal median carina. Posterior horns developed as a pair of stout bosses, never as slender, flattened horns as in *S. simson* L. Scutellum moderately coarsely punctured at middle. Elytra evenly and finely alutaceous, very finely and rather sparsely punctured, with a few incomplete rows of larger ocellate punctures. Sutural marginal bead broad and set off from rest of elytron by a deeply impressed wavy line. Pygidium of male strongly convex, very finely and sparsely punctured, basally with a transverse row of coarser setigerous punctures; that of female less convex and with two broad, shallow grooves adjacent to the apical margin, one on either side of the middle, surface coarsely punctate and transversely strigose. Posterior margin of sixth sternite of male broadly emarginate at middle and set with a single row of long setae. Anterior tibia quadridentate. Tarsal claws stout, curved, without tooth. Length, male (not including horn) 24–34 mm., female 26–39 mm.

Type locality.—? (assumed here as Cuba).

Type.—Location unknown.

Material examined: Twenty-nine males and 36 females from the following localities: Pinar del Rio City; Havana—Santiago de las Vegas and Havana City; Santa Clara—Cayamas

*See text on Strategus s. str., page 299.

and Cienfuegos; Camaguey—Nuevitas (attacking *Agave fourcroydes*), Baragua (T. P. R. F. Nos. 191, 1105, 1116, 3070, and 3593), Estrella (T. P. R. F. No. 1105), and Jaronu; and Oriente—Santiago de Cuba, Baracoa, and Guantanamo.

2. **Strategus anachoreta** Burmeister.

(Plate V, Fig. 53.)

Strategus anachoreta Burm., 1847, Handb. Ent., Vol. 5, p. 134; DuVal, in Sagra, 1856, Hist. Cuba, Vol. 7, p. 124, Pl. 9, Fig. 24; Chevrolat, 1865, Ann. Soc. Ent. France, Ser. 4, Vol. 5, p. 33.

Large to very large, uniform dark castaneous. Head polished and impunctate on vertex, frons very coarsely sculptured, clypeofrontal suture effaced across middle but located by a pair of well separated, low, blunt tubercles. Clypeus trapezoidal, rather more finely sculptured, apex broadly reflexed, side pieces strongly declivous and set off from disc by well defined carinae. Pronotum highly polished, with a few very fine punctures. Median anterior horn about twice as long as head, gently curved upward, tapering toward apex, which is subacute, its dorsal face rounded from side to side. Pronotum of male deeply excavated between the anterior horn and each of the posterolateral horns, the surface of the excavations very coarsely and irregularly scratched. Posterolateral horns each about half as long as anterior horn, somewhat compressed, acuminate apically but rounded at extreme apices. Pronotum of female with a small median anterior tubercle behind which is a shallow median excavation. Scutellum very coarsely sculptured in basal two-thirds. Elytra polished, with several incomplete rows of coarse, crateriform punctures. Interval between suture and first puncture row almost impunctate, other intervals more or less punctured. Sutural marginal bead set off from rest of elytron by a deep and almost straight groove. Pygidium convex, densely and finely punctured, with a basal band of setigerous punctures. Anterior tibia quadridentate, the upper tooth feebly developed in male. Length, 31–53 mm.

Type locality.—"Cuba."

Type.—Probably at Halle.

Material examined: One male and one female from Pinar del Rio Prov., W. Robinson; one male from Havana City, October, 1886, Dr. Balmaseda (reported injuring coconut palms); six females from Cayamas, Santa Clara, May 8–June 1, E. A. Schwarz; one female from Banos de Ciega Montera, Santa Clara, May 5, 1918; fifteen males and eight females from Baragua, Camaguey, various dates, Plank, Scaramuzza, Stahl, and Van Dine, (T. P. R. F. No. 4056); one female from Baracoa, Oriente; two females from Santiago de Cuba, Oriente; one male from "Cuba;" and one female from Nueva Gerona, Isle of Pines, Palmer and Riley.

Strategopsis new subgenus.

Scaptophilus Burm., 1847, Handb. Ent., Vol. 5, p. 122 (pars).

Strategus of moderate size and robust form, with only slight sexual modifications externally; mandible with only a trace of division into two teeth, galea of maxilla rounded at apex and armed with a single small denticle on inner margin remote from apex.

Type of subgenus.—Podalgus sarpedon Burm.

The name *Scaptophilus* was proposed by Burmeister in 1847 for a small group of species said to be related to *Bothynus* Hope. This relationship is evidenced by the form of the propygidium, the hind margin of which is not transverse but strongly arcuate. Thus the propygidium covers, in large part, the pygidium. The species originally included in *Scaptophilus* numbered seven, one of which (*Geotrupes talpa* Fabr.) was unknown, except by description, to the author. No genotype was designated.

The first of the included species is *Podalgus sarpedon* Burm. from Cuba, in which the propygidium is transverse and the galea bears a single tooth. The first of these characteristics is directly contrary to the definition of the genus; the second is not in harmony with conditions found in the other species. Three of these have the galea tridentate, in one the galea is described as subquadridentate, in one as quadridentate. Further, *P. sarpedon* Burm. is certainly strategid in its affinities, while the others appear to be pentadontids. For these reasons it seems best to pass over the first species and to select the genotype of *Scaptophilus* from among the remaining. As the tridentate condition of the galea is most common, *Podalgus complanatus* Burm., the first of the series characterized by a short pygidium and tridentate galea, is here selected as type of *Scaptophilus* Burm.

3. **Strategus (Strategopsis) sarpedon** (Burmeister).
(Plate V, Fig. 52.)

Podalgus sarpedon Burm., 1847, Handb. Ent., Vol. 5, p. 122.
[*Scaptophilus*] *sarpedon* Burm., 1847, l. c., p. 122.
Scatophilus sarpedon Chevrolat, 1865, Ann. Soc. Ent. France, Ser. 4, Vol. 5, p. 32. [*Scatophilus* misprint for *Scaptophilus*.]
Strategus sarpedon Leng and Mutchler, 1914, Bull. Amer. Mus. Nat. Hist., Vol. 33, p. 442.

Large, robust, body uniformly dark castaneous, legs somewhat rufous. Head very coarsely, closely, and confluently punctured,

clypeofrontal suture obsolete, its normal position marked by two low, widely separated tubercles, clypeus triangular, strongly margined and reflexed at apex, ocular canthi very prominent. Pronotum transverse, widest at about middle of length, basal margin slightly, and anterior margin very much, narrowed; anterior median depression shallow, slightly narrower than anterior margin, with a small rounded tubercle at middle of anterior margin in male, depression, anterior angles, and a narrow marginal band coarsely sculptured, rest of pronotum very finely and sparsely punctured; basal angles obtuse and rounded, anterior angles subacute and slightly produced. Scutellum with a few very coarse punctures. Elytra with four pairs of puncture rows, all of which are more or less abbreviated behind, the narrow intervals between members of each pair not punctured, the broad intervals between pairs very sparsely punctured. Sutural marginal bead very strongly set off from the rest of the elytron, lateral and apical margins with narrower beading. Basal half of pygidium with numerous setigerous punctures, apical half dull, without definite punctures except at extreme sides. Underparts of thorax rather coarsely and very densely sculptured except toward middle of metasternum, posterior coxal plates coarsely and less densely punctured. Anterior tibiae quadridentate, the upper tooth smaller than the others, middle and posterior tibiae irregular at apices; in fresh specimens the middle bidigitate, the posterior tridigitate, the median of the three digitations very low and hardly angulate. Length, 23–29 mm.

Type locality.—"Cuba."

Type.—Probably at Halle.

Material examined: Three females from Santiago de las Vegas, Havana, May 20–June 17, R. Amadon and O. Arango; one female from Havana City, May 19, 1926, S. C. Bruner; one female from Vedado, Havana, June 16, 1927, L. C. Scaramuzza (T. P. R. F. No. 1142); one male and eight females from Cayamas, Santa Clara, May 7–June 6, E. A. Schwarz; one male from Cienfuegos, Santa Clara; four males and three females from Baragua, Camaguey, May 7–July 16, Christenson, Scaramuzza, and Van Dine (T. P. R. F. No. 3070 and C. S. C. No. 5151); three males from Jaronu, Camaguey, May 4–June 13, Barreto and Scaramuzza; one male from Pilar, Camaguey, April 17, 1929, Scaramuzza (T. P. R. F. No. 3070); one female from Vertientes, Camaguey, April 2, 1930, L. C. Scaramuzza; one female from Cristo, Oriente, October, 1913; one male from Marimon, September 21, 1923, B. T. Barreto; and one male and two females from "Cuba."

Tribe **Phileurini.**

The four species of Phileurini which are known to inhabit Cuba and the Isle of Pines must, according to Kolbe's work, be assigned to four genera. One of these is described as new in the present paper. All four belong to the second of the two major divisions of the tribe and are characterized by having simple, acute mandibles. In the key offered below, both generic and specific characters are combined to facilitate its use.

1. Apex of posterior tibia with two broad, triangular digitations in addition to the spinose outer angle; anterior third of pronotum vertical and set off from posterior portion by a transverse row of four tubercles; median pronotal sulcus well-marked; cephalic tubercles greatly developed, much higher than thick; size larger (over 30 mm.), (Page 304) **Homophileurus**

   Apex of posterior tibia with one or no digitations in addition to spinose outer angle; cephalic tubercles never higher than their own diameters; size smaller (under 25 mm.) 2

2. Apex of posterior tibia with a single triangular digitation in addition to spinous outer angle; pronotum with a small tubercle at middle of anterior margin; median pronotal sulcus well-marked; postcoxal process of prosternum stout, its posterior face with a single transverse ridge, (Page 305) ..... **Phileurus**

   Posterior tibiae without digitation other than spinous outer angle; pronotum neither excavated in front nor with median tubercle 3

3. Cephalic tubercles well-defined but not high; pronotal sulcus distinct; postcoxal process of prosternum laminiform; anterior tarsi of sexes similar (Page 306) ..... **Epiphileurus**

   Cephalic tubercles weak and inconspicuous; pronotal sulcus reduced to a few coarse punctures; postcoxal process of prosternum hemispherical; anterior tarsus of male shorter than that of female, swollen, and with dissimilar claws (Page 307) ..... **Planophileurus**

Homophileurus Kolbe.

KOLBE, 1910, Ann. Soc. Ent. Belg., Vol. 54, p. 336.

This genus was established for five species. A sixth, *H. cubanus* Prell, was added later, based on two females from Guantanamo, Cuba.

1. **Homophileurus cubanus** Prell.

(Plate IV, Fig. 46.)

Homophileurus cubanus Prell, 1911, Ent. Zeit. Frankfurt a. M., Vol. 25, p. 106.
? Phileurus quadrituberculatus Chevr., 1865, Ann. Soc. Ent. France, Ser. 4, Vol. 5, p. 34 (err. determ.?).

Large, subdepressed, oblong, black. Head with a deep depression between the eyes, surface before the depression very coarsely sculptured with short, arcuate lines, clypeus strongly recurved and acuminate, lateral anteocular horns strongly developed, nearly erect, outer surface of clypeal process and horns impunctate. Pronotum transverse, sides very strongly arcuate, marginal bead entire except across middle of base, anterior third declivous and nearly vertical, the upper margin

of the declivity bearing four small, equally spaced tubercles which occupy the middle half of the width, standing in a gently curved line, the outer pair slightly in advance of the inner. Median sulcus as wide anteriorly as distance between inner pair of tubercles, becoming narrower toward base. Surface of declivity moderately coarsely and sparsely punctured, area just outside of outer tubercles very coarsely, rest of surface sparsely and very finely, punctured. Scutellum with a few very coarse punctures on basal half. Elytra coarsely punctate-striate, interval between first and second puncture rows with a short additional row near base, fourth and fifth rows not complete apically, intervals very finely and sparsely punctured. Pygidium shining, coarsely and sparsely punctured. Median portion of underbody impunctate, lateral portions coarsely and rather densely punctured. Anterior tibia quadridentate, the upper tooth weakly developed. Length, 40–47 mm.

Type locality.—Guantanamo, Oriente.

Type.—In collection of Dr. H. Prell.

Material examined: A single male from Camaguey City, J. Acuna.

Phileurus Latreille.

Latreille, 1807, Gen. Crust. et Ins., Vol. 2, p. 103.
Kolbe, 1910, Ann. Soc. Ent. Belg., Vol. 54, p. 336.

As restricted by Kolbe, *Phileurus* contains a few species of moderate size, one of which is represented in the Cuban fauna by a well-marked subspecies.

1. **Phileurus valgus** subsp. **antillarum** Prell.

(Plate IV, Fig. 45.)

Phileurus valgus Chevrolat, 1865, Ann. Soc. Ent. France, Ser. 4, Vol. 5, p. 33. (nec *P. valgus* L. s. str.)
Phileurus valgus subsp. *septentrionis* Kolbe, 1910, Ann. Soc. Ent. Belg., Vol. 54, p. 352 (pars).
Phileurus valgus subsp. *antillarum* Prell, 1912, Ent. Blatt., Vol. 8, p. 179.

Of moderate size, depressed, oblong, black. Head with frons shallowly concave, coarsely sculptured with short, deep, transverse lines, ocular canthi weakly tuberculate, lateral cephalic tubercles low, blunt but distinct, clypeus reflexed and sharply acuminate, with a low carina leading to its apex from each of the tubercles, surface of clypeus finely and rather sparsely punctured. Pronotum transverse, sides broadly rounded, marginal bead entire, median longitudinal sulcus deep, ending anteriorly in a small tubercle just behind the margin, anterior portion coarsely and moderately densely, disc (except sulcus) and basal portion finely and sparsely punctured. Scutellum usually impunctate. Elytra coarsely punctate-striate, the punctures ocellate, the alternate interspaces broader and raised as costae, surface between coarse punctures finely and sparsely punctate. Pygidium strongly

convex, coarsely and sparsely punctured in male, basal half deeply, transversely grooved in female. Underparts very coarsely and rather sparsely set with ocellate punctures laterally, impunctate medianly. Each abdominal sternite with a single row of coarse punctures at base. Anterior tibia quadridentate, the opposing margins of the apical and subapical teeth parallel. Length, 17–20 mm.

Type locality.—Guadeloupe.

Type.—In the collection of Dr. H. Prell.

Material examined: One male and one female from near Havana City, M. T. Cook; two females from Santiago de las Vegas, Havana, January 29 and June 24, 1926, A. Otero; two males and one female from Cayamas, Santa Clara, March 7 and April 17, G. Dimmock and E. A. Schwarz; two males and three females from Baragua, Camaguey, various dates from May 28 to November 10, L. C. Scaramuzza and C. F. Stahl (T. P. R. F. No. 249); and two females from Jaronu, Camaguey, April 15 and June 23, 1930, L. C. Scaramuzza.

This subspecies is not distinguishable by external characteristics from *P. v. septentrionis* Kolbe. The two differ in the shape of the inner lobate branch of the lateral lobe of the oedeagus, which in the North American form is sharply excised near its middle. While material from Guadeloupe is not available to the writer for study, Prell's description applies perfectly to the Cuban specimens at hand.

Epiphileurus Kolbe.

KOLBE, 1910, Ann. Soc. Ent. Belg., Vol. 54, p. 336, 342.

In addition to certain Central American species, Kolbe ascribed to this genus two Cuban species, one of which appears to the writer to be too aberrant to remain here and is made the type of a new genus.

1. **Epiphileurus cribratus** (Chevrolat).

(Plate IV, Fig. 44.)

Phileurus cribratus Chevr., in Guerin, 1829–38, Icon. Regne Animal, p. 90, Pl. 23, Fig. 5; Burm., 1847, Handb. Ent., Vol. 5, p. 524; Chevr., 1865, Ann. Soc. Ent. France, Ser. 4, Vol. 5, p. 33.
Epiphileurus cribratus Kolbe, 1910, Ann. Soc. Ent. Belg., Vol. 54, p. 342.

Small (for tribe), depressed, oblong, shining, deep castaneous. Head with frons deeply concave, shining, sparsely and rather finely punctured at sides. Clypeus acuminate and reflexed, very sparsely and finely punctured. Lateral cephalic processes low, transverse and truncate apically, the ocular canthi bearing each a much smaller and

rounder tubercle. Pronotum transverse, sides broadly rounded, apical angles acute and slightly produced, basal angles rounded, marginal bead complete. Median sulcus broad and complete, coarsely and densely punctured. Rest of pronotum coarsely, sparsely, and rather irregularly punctured, the punctures more dense on anterior half near anterior angles. Scutellum with a very few coarse punctures. Elytra very coarsely punctate-striate, with the alternate intervals slightly raised, the punctures in the rows separated by less than their diameters. Surface between punctures very finely and sparsely punctured. Pygidium strongly convex in male, nearly flat in female, rather coarsely and densely punctured. Underparts shining, median portion of metasternum with a few rather fine, the lateral portions with relatively very large, punctures. Abdominal sternites each with a transverse, basal row of large punctures. Anterior tibia sharply tridentate, anterior tarsi alike in the sexes. Length, 12–13 mm.

Type locality.—"Cuba."

Type.—Probably at Paris Museum of Natural History.

Material examined: One male from Cayamas, Santa Clara, March 6, E. A. Schwarz; one female from Santiago de Cuba, Oriente; and one female without data.

Planophileurus new genus.

Epiphileurus Kolbe, 1910, Ann. Soc. Ent. Belg., Vol. 54, p. 342 (pars).

Phileurini having simple acute mandibles; pronotum without median sulcus or tubercle; postcoxal process of prosternum thick, wide, low, subhemispherical; posterior tibia without digitations other than the prolonged outer apical angle and with anterior tarsi of male strongly dilated with dissimilar claws.

Type of genus.—Phileurus planicollis Chevrolat, 1865.

The species for which this new genus is erected is striking among *Phileurini* because of the unusually depressed form and the highly polished pronotum without median sulcus. The enlargement of the anterior male tarsi is a characteristic not unknown among New World *Phileurini* and commonly met with among the Asiatic species. The conformation of the oedeagus of *P. planicollis* indicates that the relationships of this genus lie in the direction of *Hemiphileurus* Kolbe rather than with *Epiphileurus*.

1. **Planophileurus planicollis** (Chevrolat).
(Plate IV, Fig. 43.)

Phileurus planicollis Chevr., 1865, Ann. Soc., Ent. France, Ser. 4, Vol. 5, p. 34.
Epiphileurus planicollis Kolbe, 1910, Ann. Soc. Ent. Belg., Vol. 54, p. 342.

Of medium size, depressed, oblong, black. Head with frons shallowly concave, sparsely and moderately coarsely punctured. Ocular canthi

wide, flat, not tuberculate. Cephalic tubercles low, in form of transverse ridges connected with canthi and, from their inner extremities, with apex of clypeus. Clypeus acuminate and reflexed, with lateral carinae, one extending to each canthus. Pronotum transverse, sides strongly arcuate, marginal bead absent across disc both anteriorly and basally, median sulcus absent, but its usual position indicated on basal half by a few coarse punctures, surface polished, very finely and sparsely punctured on disc, more coarsely so along lateral margins. Scutellum with a few coarse punctures at base. Elytra deeply punctate striate, the interspaces of uniform width and elevation, the punctures not half as wide as interspaces, surface between punctures very finely and sparsely punctured. Pygidium strongly convex, very coarsely punctured in male, more finely so in female. Underparts as in *E. cribratus* Chevr. Anterior tibia sharply tridentate, anterior tarsus of male short, the fourth segment prolonged in an acute lobe beneath the fifth, which is strongly inflated and terminates in two dissimilar claws. The larger (inner) claw very broad, sharply bent at middle of length and furnished at the angle with a short acute spur. Anterior tarsus of female normal. Length, 16–19 mm.

Type locality.—"Cuba."

Type.—Location unknown.

Material examined: One male from Herradura, Pinar del Rio, April 11, 1905, G. Dimmock; one male and two females from Santiago de las Vegas, Havana, April 10, 1905, G. Dimmock, and May 12, 1922, J. Acuna; one female from near Havana City, May 31, 1905, M. T. Cook; and two females from "Cuba," in the Poey Collection, Philadelphia Academy of Sciences.

Subfamily **CETONIINAE.**

This subfamily, while rich in genera and species in continental America, is represented in the Cuban fauna by two genera, each by a single species. As yet no Cetoniine has been recorded or seen from the Isle of Pines. Both of the genera belong to the tribe *Gymnetini*, characterized (among the New World groups) by the almost total concealment of the scutellum by the pronotal lobe.

1. Head armed with a T-shaped (male) or subquadrate (female) process on the clypeal margin; pronotum with a small tubercle near anterior margin (Page 309)..... **Tiarocera**
   Head and pronotum unarmed (Page 310)..... **Gymnetis**

Tiarocera Burmeister.

BURMEISTER, 1842, Handb. Ent., Vol. 3, p. 247, 248.

This genus was based on two species, the first and presumably the type from Brazil, the second from Cuba. Closely related to *Allorrhina* Burm. and *Cotinis* Burm., it is distinguished from the first of these by the toothed anterior tibiae of the male and from the second by sexual differences in the conformation of the clypeal process.

1. **Tiarocera cornuta** (Gory and Percheron).

(Plate VI, Fig. 59.)

Gymnetis cornuta G. and P., 1833, Mon. Cetoines, p. 69, Pl. 65, Fig. 2.
Tiarocera cornuta Burm., 1842, Handb. Ent., Vol. 3, p. 248.
Allorhina (*Tiarocera*) *cornuta* Chevr., 1865, Ann. Soc. Ent. France, Ser. 4, Vol. 5, p. 34.
Allorhina cornuta Leng and Mutchler, 1914, Bull. Amer. Mus. Nat. Hist., Vol. 33, p. 442.

Oblong-ovate, shining, uniformly deep piceous-black, sometimes with a greenish luster, palpi deep castaneous, body sparsely clad with ferruginous hair. Head very coarsely areolate, portion before eyes nearly square, with anterior angles broadly rounded, lateral margins and median line strongly elevated. Median carina of male high and acute on vertex, abruptly ending just before the clypeal process, that of the female much lower, subacute on vertex, ending at level of eyes and merging into a low broad ridge which reaches the clypeal apex. Margin of clypeus strongly reflexed and produced upward in a process which in the male, when fully developed, is T-shaped and resembles the clypeal process of certain species of *Dicranorrhina* and which in the female is slightly higher than wide at base, the sides feebly concave and apex broadly and shallowly emarginate. The process itself is densely and rather finely punctured. Pronotum slightly broader than its extreme median length, anterior transverse diameter less than half greatest width, lateral margins evenly curved from the moderately rounded anterior angles to the broadly rounded basal angles, basal margin biconcave, the median lobe subacute and nearly covering the scutellum. A small median tubercle present just behind the anterior margin. Surface moderately densely set with coarse semicircular pits, these a little more densely placed anteriorly and laterally. Lateral and basal margins coarsely beaded, median line faintly impressed on disc, slightly elevated before scutellum. Elytra with horseshoe-shaped punctures arranged in irregular rows, the intervals more minutely but similarly punctured, except for two on each elytron, which are the homologues of the usual discal costae. Lateral margins broad basally, obsolete beyond the middle of the length. Pygidium deeply, transversely, and irregularly scratched. Metasternum smooth at middle, coarsely sculptured laterally, side pieces coarsely sculptured, intermesocoxal process broad and flat, rounded in front. Abdominal sternites minutely

and very sparsely punctured at middle, rather densely set with inverted V-shaped punctures laterally. Anterior tibia with apical and subapical teeth strongly developed. Length, 20–24 mm.

Type locality.—"Cuba."

Type.—Location unknown.

Material examined: One male of minor development from Cerro Cabras, Pinar del Rio, September 11, 1913; one female from Baragua, Camaguey, October 9, 1926, collected in soil by D. L. Van Dine (T. P. R. F. No. 2071); one female from Guantanamo, Oriente, June 15, 1908, C. T. Ramsden; and five females from Santiago de Cuba, Oriente, W. Robinson.

In the above description, the information concerning the major development of the male is derived from the figure in Gory and Percheron's monograph.

Gymnetis MacLeay.

MacLeay, 1819, Horae Ent., Vol. 1, p. 152.

In contrast with *Tiarocera*, this genus is a large one whose many species are distributed over the territory south of the United States-Mexican boundary. Species are known to inhabit Jamaica, Haiti, and other West Indian islands. A single species is known from Cuba.

1. **Gymnetis sternalis** Chevrolat.

(Plate VI, Fig. 58.)

Gymnetis sternalis Chevr., 1865, Ann. Soc. Ent. France, Ser. 4, Vol. 5, p. 35.

Elongate-pentagonal, greatest width across mesepimera, dull brownish-black with vermiculations of yellowish-brown above, somewhat shining with a purplish-bronze luster beneath, intermesocoxal process strongly shining. Head nearly flat, portion in front of eyes nearly square, lateral margins feebly, apical margin strongly, elevated, sides of front coarsely and irregularly scratched, median portion sparsely and rather finely punctured, surface almost entirely yellowish-brown. Pronotum moderately convex, anterior margin not quite half of extreme width of pronotum, shallowly triconcave, the median concavity broad and shallow, the lateral concavities sufficient to uncover a portion of the eyes, lateral margins feebly sinuate, basal margin bisinuate on either side of the middle, median lobe broad and rounded. All margins without marginal bead. Disc impunctate, flanks sparsely and rather coarsely punctured. Anterior half with a few irregular, poorly defined but symmetrically placed yellow-brown markings, three quite irregular lines with supplementary spots on either side appearing to be the fundamental pattern. Mesepimera large, with a few coarse punctures, surface above uniform yellow-brown. Elytra finely and sparsely set

with small horseshoe-shaped or inverted V-shaped punctures on the lateral halves, disc almost impunctate. The yellow-brown markings extend in from the lateral and apical margins irregularly and not symmetrically, more conspicuously so along apical margin. Epipleura broad basally, becoming finer and disappearing at the turn of apical margin. Pygidium densely set with coarse, inverted V-shaped or U-shaped punctures. Underparts coarsely and densely sculptured laterally, median portion finely and sparsely punctured in male, highly polished and without punctures in female. Intermesocoxal process long, deflected at tip, which is bluntly rounded. Mesosternum with a deep longitudinal groove behind the process. Anterior tibia obsoletely tridentate in both sexes, the teeth in the female more conspicuous than in the male. Length, 20 mm.

Type locality.—"Cuba."

Type.—Probably in collection of O. E. Janson.

Material examined: One male from Havana Prov., February 15, 1931; and one female from Manacas, Santa Clara, 1930.

EXPLANATION OF PLATES.

(Magnification ca × 10.)

OEDEAGI.

PLATE IV.*

Fig. 41. *Ligyrus fossor* (Latr.).
Fig. 42. *Ligyrus tumulosus* (Burm.).
Fig. 43. *Planophileurus planicollis* (Chevr.).
Fig. 44. *Epiphileurus cribratus* (Chevr.).
Fig. 45. *Phileurus valgus antillarum* Prell.
Fig. 46. *Homophileurus cubanus* Prell.
Fig. 47. *Cyclocephala signatoides* n. sp.
Fig. 48. *Cyclocephala cubana* n. sp.
Fig. 49. *Cyclocephala verticalis* Burm.
Fig. 50. *Cyclocephala atricolor* n. sp.

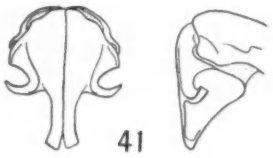
PLATE V.

Fig. 51. *Strategus (s. str.) ajax* (Oliv.).
Fig. 52. *Strategus (Strategopsis) sarpedon* (Burm.).
Fig. 53. *Strategus (s. str.) anachoreta* Burm.
Fig. 54. *Dyscinetus picipes* (Burm.).
Fig. 55. *Dyscinetus laevipunctatus* Bts.
Fig. 56. *Dyscinetus frater* Bts.

PLATE VI.

Fig. 57. *Anomala calceata* Chevr.
Fig. 58. *Gymnetis sternalis* Chevr.
Fig. 59. *Tiarocera cornuta* (G. and P.).
Fig. 60. *Rutela formosa* Burm.

*Plates I–III appeared in Part I, published in Vol. XXV, pp. 173–209, March, 1932.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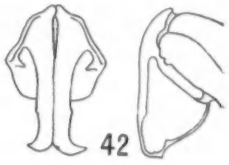
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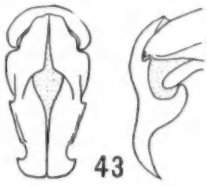
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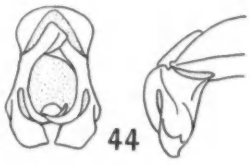
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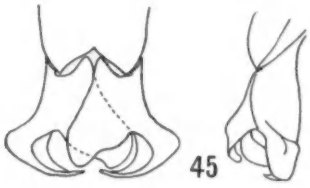
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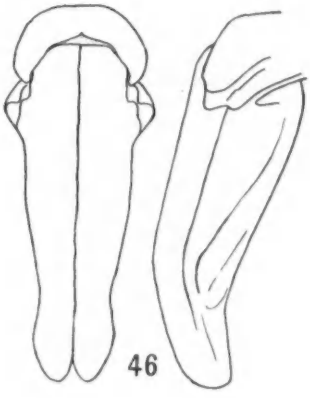
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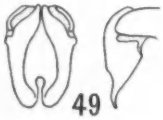
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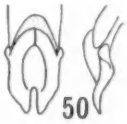
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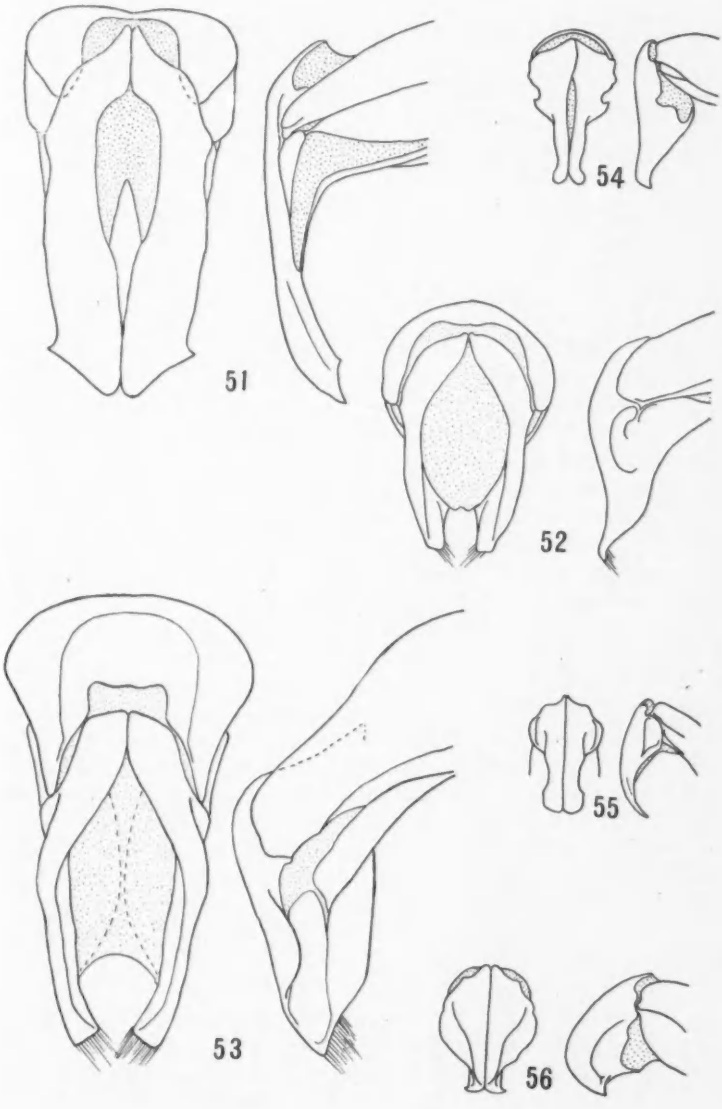
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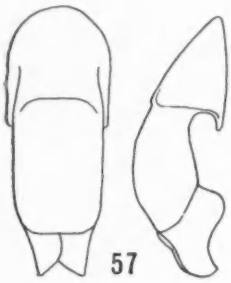

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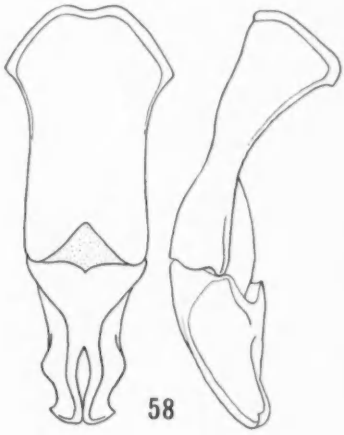

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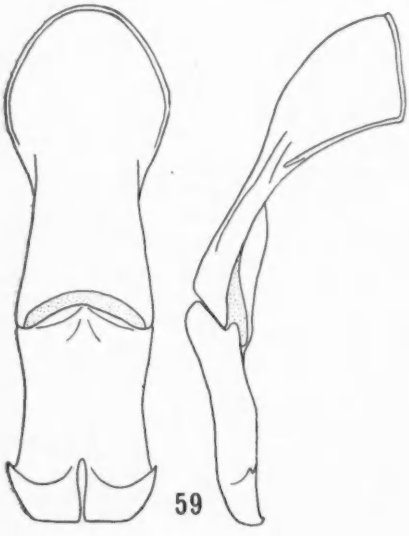

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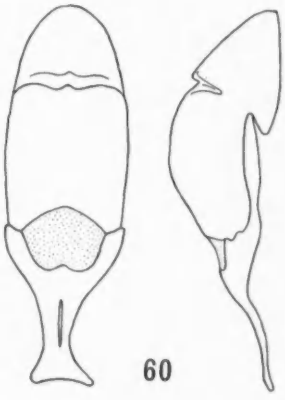

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DETERMINATION OF TOTAL BLOOD VOLUME IN THE COCKROACH, P. FULIGINOSA, WITH SPECIAL REFERENCE TO METHOD.

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In many types of experimental work, especially those involving toxic or anesthetic effects of injected or absorbed materials upon animals it is desirable to have some knowledge of the extent to which the materials become diluted by the circulating blood. This necessitates a knowledge of total blood volume. The present paper is a report of the determination of total blood volume in the cockroach, *Periplaneta fuliginosa* Serville, by two different methods, one of which is a modification of a dilution method already employed in connection with problems relating to man and the mammals generally; the other is a modification of a direct method already in use for the determination of blood volume in insect larvae. An attempt is made to evaluate at least approximately the magnitude of the experimental errors of the dilution method.

Erlanger (1), in a review of blood volume determination in mammals, divides existing methods into two groups, the "direct" methods, based upon an actual removal of the entire blood volume from the experimental animal, and the "indirect" methods, based upon the removal and comparison of at least two blood samples. Welcker's method (2) is a well known direct method. Examples of indirect methods are the dilution method of Valentin (3), whom Erlanger cites as being the first to conceive of and apply an indirect method of blood volume determination, the carbon monoxide inhalation method as modified by Haldane and Smith (4) or by Zuntz and Plesch (5), the vital red method of Keith, Rowntree and Geraghty (6), the gum acacia (injection) method of Meek and Gasser (7) and the corpuscle (injection) method of Ashby (8). Many of these methods involve large experimental errors, when applied to even large mammals, including man. A critical study of the vital red method has been made by Fleischer-Hansen (9), who shows that the error of this method is of the order of not less than plus or minus seven per cent even when applied to the determination of blood volume *in vitro*. One might expect

that the magnitude of the error of any one of these methods will be considerably greater when the method is applied to very small animals from which only minute amounts of blood can be obtained. The experiments reported below indicate that such is the case. It is obvious that those methods which depend upon the presence of hemoglobin in the circulating blood are inapplicable to the insect.

Attempts to determine blood volumes of insects are infrequently reported in the literature. In a recent paper by Richardson, Burdette and Eagleson (10) two methods are described, one of which has been used in modified form in the present work, for estimating blood volumes of insect larvae. This paper refers to the more important literature of the subject. The methods referred to are all simple bleeding methods or modifications of the latter. The insects used were in the larval stage of development.

The material used in the present experiments consists of individuals of *Periplaneta fuliginosa* of various sizes and stages of development, including the adult. They were all from the same colony kept under the same (though uncontrolled) environmental conditions of room temperature, humidity and food supply. The latter consisted largely of banana.

METHODS.

(a) *The corpuscle dilution method:* The dilution method used here is a modification of one devised by Valentin (3) and, in principle, is not dissimilar to the hematocrit method of Kottmann (11) for mammals. Valentin's method consisted of determining the percentage of solids in an initial sample of blood, injecting a known volume of distilled water into the experimental animal (mammal), taking a second sample of blood (after a suitable lapse of time) and determining the percentage solids in the diluted blood. A value for blood volume is then calculated from $V = pw/(p-q) + b$, where V is the total blood volume, p the percentage of solids in the initial and q that in the final sample of blood, w the volume of water injected and b the volume of the initial blood sample. Other investigators have used saline instead of distilled water and have measured other components of the blood than total solids. Since many electrolytes are known to penetrate the capillary wall (7, 12), the use of even an isosmotic saline solution is not without objections, when applied to an animal such as the vertebrate, having a closed type of circulatory system. This objection to the dilution method need not be carried over to the invertebrate, which has an open type of circulatory system, permitting the tissue cells to be bathed directly by the circulating body fluid.

In applying the dilution method to the cockroach, it is assumed that the initial volume of blood (undiluted) is to the final volume (diluted) as the final total blood cell count is to the initial cell count, or that

$$V_o' \cdot C_o = V_1 \cdot C_1 ,$$

where V_o' is the initial blood volume minus the volume of the initial blood sample, C_o the initial blood cell count, V_1 the final blood volume and C_1 the final cell count. Since $V_1 = V_o' + d$, where d is the volume of fluid injected into the animal,

$$V_o' \cdot C_o = (V_o' + d) \cdot C_1$$

or

$$V_o' = \frac{d \cdot C_1}{C_o - C_1} .$$

Accounting for the volume of the initial blood sample, the expression becomes

$$V_o = \frac{d \cdot C_1}{C_o - C_1} + a , \quad \ldots\ldots\ldots\ldots (1)$$

where V_o is the initial blood volume of the animal before the withdrawal of the initial blood sample and a is the volume of the initial blood sample.

In practice the procedure now to be described has been followed: A minute but known volume of Tuerk solution,[1] containing an excess concentration of dye, is drawn into the end of a white blood cell diluting pipette and is then carefully expelled upon the surface of the roach at the point where the initial sample of blood is to be drawn. The location of this point is on the dorsolateral surface (conjunctiva) of the neck. A fine needle is at once thrust through the drop of diluting fluid and through the underlying translucent exoskeleton which in many animals, especially those yielding large initial samples and those which have received injections of fluid, bulges in a conspicuous manner. The blood mixes with the diluting fluid as it emerges from the animal and the mixture is immediately drawn into the diluting pipette along with any other blood that escapes. Care is taken that all of the diluting fluid is recovered. The pipette is then filled with Tuerk solution and the contents shaken from two to three minutes. Meanwhile, the weight of the animal minus the initial blood sample is obtained. Three drops of diluted blood from the pipette are discarded and the double chambers of two Levy Counting Chambers are filled with drops from the fluid remaining in the pipette. The coxa of the animal's metathoracic leg (usually the left) is then severed proximally to the distal joint and the

[1]The formula for Tuerk solution is:

2% solution glacial acetic acid,
Color with Gentian Violet.

Descriptions of methods of making total blood cell counts can be found in a number of textbooks and manuals or in a pamphlet supplied with counting chambers by Arthur H. Thomas Company; the pamphlet is entitled "An improved technique for blood counting prepared especially for use with Levy counting chambers and Levy-Hausser counting chambers."

end of a small improvised canula forced into the open end of the severed coxa. The canula is tied into position with a wet thread. The other end of the canula is attached to a microburette of 5 cc. capacity, graduated to 0.02 cc. A known volume of fluid[2] is allowed to flow into the animal, the quantity injected depending upon the size of the roach. The circulating blood and injected saline are given time to mix while the initial blood count is being made, the time interval being about 30 or 40 minutes. The blood counts are thus made by two different persons, designated by (1) and (2) in the illustrative example given below, whose results are averaged, the mean being taken as the value of the count. A second sample of blood (diluted) is taken from the neck as before, but from the opposite side. In most cases, enough of the diluted blood is available to permit a dilution of 1 to 20. After suitable shaking and voiding of the first three drops, the final cell count is obtained as before.

The following typical experiment, in which a check to the final count was made, will serve as an illustrative example:

EXP. 15 Roach, adult; body weight = 0.6286 gms.

a = vol. initial blood sample = 0.022 cc. = 22 mm³.
Initial count; dilution of 1 to 20:

(1) 87 + 79 + 76 + 95 + 77 + 82 + 74 + 69 + 88 = 727 cells.
88 + 102 + 99 + 101 + 82 + 84 + 67 + 92 + 85 = 800 cells.
(727 + 800) cells counted in area of 18 mm².
Count = (1527 ÷ 18) · 200 = 16,966 cells/mm³.

(2) 68 + 90 + 91 + 87 + 93 + 66 + 88 + 75 + 92 = 750 cells.
84 + 100 + 83 + 69 + 93 + 66 + 99 + 89 + 85 = 768 cells.
(750 + 768) cells counted in area of 18 mm².
Count = (1518 ÷ 18) · 200 = 16,866 cells/mm³.

C_o = (16,966 + 16,866) ÷ 2 = 16,916 cells/mm³.
% diff. (1) and (2) = 0.7.

d = vol. fluid injected = 0.3 cc. = 300 mm³.

Final count; dilution of 1 to 40:

(1) 1 + 4 + 6 + 3 + 1 + 0 + 1 + 2 + 5 = 23 cells.
3 + 3 + 4 + 6 + 3 + 1 + 2 + 1 + 2 = 25 cells.
(23 + 25) cells counted in area of 18 mm².
Count = (48 ÷ 18) · 400 = 1040 cells/mm³.

(2) 3 + 3 + 1 + 3 + 2 + 1 + 1 + 4 + 4 = 22 cells.
1 + 3 + 1 + 2 + 3 + 4 + 3 + 4 + 6 = 27 cells.
(22 + 27) cells counted in area of 18 mm².
Count = (49 ÷ 18) · 400 = 1,089 cells/mm³.

C_1 = (1040 + 1089) ÷ 2 = 1065 cells/mm³.
% diff. (1) and (2) = 4.6.

Check to final count; dilution of 1 to 20:

(1) 4 + 4 + 3 + 5 + 3 + 8 + 4 + 5 + 6 = 42 cells.
5 + 2 + 7 + 1 + 1 + 3 + 4 + 4 + 6 = 33 cells.
(42 + 33) cells counted in area of 18 mm².
Count = (75 ÷ 18) · 200 = 832 cells/mm³.

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[2]The injection fluid employed in these experiments is that used by Hobson (16) in experiments with the fore-gut of *Dytiscus*. Its composition is:

0.161 M NaCl
0.003 M KCl
0.002 M $CaCl_2$.

(2) $13 + 7 + 4 + 4 + 4 + 4 + 1 + 1 + 7 = 45$ cells.
$8 + 3 + 9 + 0 + 7 + 3 + 4 + 5 + 2 = 41$ cells.
$(45 + 41)$ cells counted in area of 18 mm².
Count $= (86 \div 18) \cdot 200 = 895$ cells/mm³.

Check to final count $= (832 + 895) \div 2 = 864$ cells/mm³.
Per cent diff. between final count and check = 7.3.

Total blood vol. on basis final count:

$$V_o = \frac{300 \cdot 1065}{16916 - 1065} + 22 = 42.2 \text{ mm}^3.$$
$$= 43.9 \text{ mgms.}$$

V_o = total blood volume on basis check to final count = 38.1 mm³.
Per cent diff. between two blood vol. determinations = 10.2.
(Blood weight)/(Body weight) ratio = 0.070 (Final Count).
(Blood weight)/(Body weight) ratio = 0.063 (Check to final count).

(b) *Filter paper method:* This method is essentially that described by Richardson, Burdette and Eagleson (10) for larvae, except that the animal is not etherized and is not dissected open. Dissection was attempted but was finally abandoned because of difficulties resulting from rapid coagulation. The estimations were made as follows: The body weight of the experimental animal is obtained. A quantity of filter paper is torn into small pieces and weighed in a weighing bottle. The paper is then removed from the bottle. Both antennae of the roach are severed and the emerging drops of blood are absorbed by the small pieces of paper. The latter are quickly placed in the weighing bottle, which is kept closed except when receiving the paper in order to prevent excessive evaporation. In this way as much blood as possible is forced from the antennae, dorsoventral pressure being applied to the animal by thumb and fingers. The tips of the legs are then severed successively, as much blood as possible being forced from them. When no more fluid can be forced from the animal, the remaining pieces of filter paper are also replaced in the weighing bottle and the latter plus its contents weighed. The weight of the body fluid is obtained by subtraction and its volume in cubic centimeters obtained by dividing its weight by the specific gravity of the blood. The latter is assumed to be 1.04 (10).

The following experiment will serve as an example of the procedure:

Exp. 4. Cockroach adult.

Blood from antennae and legs. Pressure.

Weighing bottle + roach	= 11.5207	gms.
Weighing bottle	= 10.8187	"
Roach	= 0.7020	"
Bottle + paper + blood	= 11.0394	"
Bottle + paper	= 10.9998	"
Blood	= 0.0396	"

Blood weight/body weight = 0.056.

Blood volume = 0.0396 ÷ 1.04 = 0.0381 cc. = 38.1 mm³.

RESULTS.

(a) *Corpuscle dilution method:* The results of determinations on 18 different individuals of *P. fuliginosa* by this method are expressed in the following table.

TABLE I.

RESULTS OF BLOOD VOLUME DETERMINATIONS BY THE CORPUSCLE DILUTION METHOD.

Exp.	Vol. Init. Bl. Samp. c. c. (=a)	Init. C't Cells/mm³ Blood ($=C_o$)	Per cent Diff. (1) and (2) Init. C't.	Vol. Inj. Fluid in mm³ (=d)	Final C't. Cells/mm³ Blood ($=C_1$)	Per cent Diff. (1) and (2) Final C't.	Bl. Vol. in mm³ (in mgm) ($=V_o$)	Roach Body W't. (gms.)	Bl. W't. / Body W't. Ratio
1 ad.	0.0220	18478 (1663)	6.8	1650	101 (528)	24.0	31.0 (32.2)	*0.9969	0.032
2 ny.	0.0242	19978 (1893)	10.7	250	926 (334)	24.7	36.3 (37.8)	0.5081	0.074
3 ny.	0.0062	34721 (1740)	1.0	2000	4232 (765)	4.7	34.0 (35.3)	0.4838	0.073
4 ad.	0.0220	42388 (3815)	15.2	400	2655 (239)	0.8	48.7 (50.6)	0.8460	0.060
5 ny.	0.0062	20527 (1036)	3.8	300	2570 (387)	5.4	49.4 (51.4)	0.4420	0.116
6 ny.	0.0044	69355 (1880)	2.2	200	2699 (243)	0.7	12.5 (13.0)	0.4605	0.028
7 ny.	0.0066	50660 (2739)	11.2	260	3218 (479)	16.3	24.2 (25.2)	0.4515	0.056
8 ny.	0.0077	20646 (652)	4.3	300	1470 (264)	4.1	30.7 (31.9)	0.5607	0.057
9 ny.	0.0055	34450 (1108)	5.3	400	1217 (219)	19.1	20.7 (21.5)	0.4688	0.046
10 ny.	0.0057	24917 (1165)	8.4	300	2440 (441)	36.1	38.2 (39.8)	0.5745	0.069
11 ny.	0.0033	42693 (1146)	0.6	340	3730 (773)	28.4	35.4 (36.8)	0.5216	0.071
12 ad.	0.0035	35063 (1010)	21.7	300	2020 (374)	17.8	22.4 (23.3)	0.4495	0.052
13 ad.	0.0077	23684 (1496)	16.6	300	2738 (493)	7.7	46.9 (48.8)	0.5460	0.089
14 ad.	0.0154	25095 (2561)	0.7	320	2510 (452)	2.7	50.8 (52.8)	0.4777	0.111
15 ad.	0.0220	16916 (3045)	0.7	300	1065 (97)	4.6	42.2 (43.9)	0.6286	0.070
ck.	"	"	"	"	864 (161)	7.3	38.1 (39.7)	"	0.063
16 ny.	0.0132	22511 (2425)	6.8	200	1521 (264)	33.5	27.7 (28.8)	0.4291	0.067
ck.	"	"	"	"	1627 (293)	26.6	28.7 (29.9)	"	0.070
17 ny.	0.0044	19589 (705)	11.7	245	2527 (455)	3.1	40.7 (42.3)	0.4782	0.089
ck.	"	"	"	"	2527 (455)	8.3	40.7 (42.3)	"	0.089
18 ny.	0.0101	28622 (2376)	4.1	245	3162 (579)	29.6	40.5 (42.1)	0.5084	0.083
ck.	"	"	"	"	1461 (263)	46.4	23.2 (24.2)	"	0.048
ck.	"	"	"	"	5692 (1024)	5.2	70.9 (73.7)	"	0.145
ck.	"	"	"	"	4788 (862)	28.5	59.3 (61.7)	"	0.121
Average	0.0106	30572	7.3	462	2267	14.6	35.1 (36.5)	0.5462	0.069

First vertical column: ad=adult; ny=nymph; ck=check.

Third and Sixth column: Upper figure is cell count; lower figure, in parentheses, number of cells actually counted.

Fourth and Seventh columns: (1) and (2) refer to parallel counts made by different persons (the authors), as shown in illustrative example under Methods. The figures are differences between (1) and (2) counts expressed as per cent of the mean value of the two counts.

Eighth column: Upper figure is blood volume in mm³; lower figure, in parentheses, blood weight in mgms.

Ninth column: Weight of animal after initial blood sample is taken.

Averages, given in last horizontal column, do not include checks to the final counts.

In the case of experimental 18 an irregularity occurred in obtaining the sample of diluted blood for the first check, producing a large difference (about 50 per cent) between the final count and the first check to the final count; it is suspected that regurgitated fluid from the crop became mixed with the blood sample. The suspicion could not be confirmed. The average (Blood weight)/(Body weight) ratio of the three checks is 0.105 and the per cent difference between this value and that based on the final count is approximately 12 per cent. The per cent difference between (Blood weight)/(Body weight) ratios, expressed as per cent of the mean, is 10.4 in experiment 15 and 4.3 in experiment 16.

(b) *Filter paper method:* The results obtained by this method are given below:

TABLE II.

RESULTS OF BLOOD VOLUME DETERMINATION BY THE FILTER PAPER METHOD.

Exper. No.	Body Weight (gms.)	Blood Weight (gms.)	$\frac{\text{Blood Weight}}{\text{Body Weight}}$ Ratio
1 ad.	0.5751	0.0216	0.038
2 ad.	0.3491	0.0107	0.031
3 ny.	0.6066	0.0361	0.060
4 ad.	0.7020	0.0396	0.056
5 ny.	0.3078	0.0220	0.071
6 ad.	0.5391	0.0382	0.071
7 ad.	0.5384	0.0240	0.045
8 ad. ♀	0.9211	0.0333	0.036
9 ad. ♂	0.6040	0.0208	0.034
10 ny.	0.4676	0.0254	0.054
11 ny.	0.4455	0.0162	0.036
12 ad.	0.7649	0.0212	0.028
13 ad. ♀	0.8531	0.0553	0.065
14 ad.	0.5671	0.0448	0.079
15 ad. ♀	0.9748	0.0430	0.044
16 ny.	0.4599	0.0188	0.041
17 ny.	0.5410	0.0211	0.039
18 ad. ♀	0.5269	0.0245	0.046
19 ad. ♀	0.9719	0.0291	0.030
20 ny.	0.5940	0.0202	0.034
Average.	0.6155	0.0283	0.047

Roach number 6 was a soft, white adult that had just completed its last molt.

DISCUSSION.

The above results indicate that the average total blood cell count of *P. fuliginosa* is approximately 30,000 cells per mm³ of undiluted blood, the range of values extending roughly from about 15,000 to 60,000.[3]

[3]A number of total cell counts have been made on the blood of *Blatta orientalis* by Mr. W. E. Shull (this laboratory), who finds the average value to be approximately 20,000 cells per mm³ blood.

The count of 69,355 appears to be singularly high. These figures are considerably greater than the figures obtained by Haber (13) from the blood of *Blatta germanica*. Haber, using a rough method of counting, estimates the total number of cells in the cockroach body to range from 42,000 to 99,200, whereas calculation based on the average figures presented above indicates a total body content of approximately 1,050,000 blood cells. Although it is admittedly unwise to reason too much from one species to another, it seems probable that the latter is the more representative figure.

A comparison of the values for total blood volume, obtained by the two methods described above, shows that the total blood (in grams), taken as per cent of body weight, is on the average somewhat higher by the dilution method than by the filter paper method. This discrepancy may receive an explanation from the facts that, first, it is difficult to express all of the blood from the cockroach body and, secondly, it is difficult to prevent excessive evaporation from the absorbing filter paper. The two sets of results, though different,[4] are surprisingly close.

The means of the two sets of determinations may be expressed as 6.6 cc. per 100 gms. of body weight (dilution method) and 4.7 cc. per 100 gms. body weight (filter paper method). These figures are lower than those obtained by Richardson, Burdette and Eagleson (10) working with the larvae of *Bombyx mori* and *Galleria mellonella*. Their results were 31.2 cc. blood per 100 gms. body weight by their absorption method and 28.6 cc. per 100 gms. body weight by their dry weight method, using *Bombyx* in both cases; and 41.0 by their dry weight method, using *Galleria*. Their results are of the same order as those obtained by other investigators using larval forms. These results indicate that the relative blood volume of the cockroach is only about one-third that of the insect larvae for which values have been reported. Haber's (13) hypothetical figure for total blood volume of *Blatta* (20 per cent of body weight), though lower than the figures just quoted, is much greater than the average value of about 7 per cent obtained for *P. fuliginosa*.

Of greater interest is the report by Barratt and Arnold (15) that they were able to remove with a pipette an average of 0.32 cc. of blood from 5 specimens, of 0.14 cc. from three specimens and of 0.26 cc. from another group of individuals of *Hydrophilus piceus*. From *Dytiscus marginalis* they obtained in the same way an average of 0.14 cc. from 3 individuals, of 0.063 cc. from 6 individuals, of 0.108 cc. from 12 individuals and of 0.10 cc. from 17 specimens.

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[4]The difference between the two means is 0.022 ± 0.0067, where 0.0067 is the standard error of the difference as determined by the formula: $\sqrt{\sigma_1^2 + \sigma_2^2}$ See Fischer (16).

CRITICISM OF THE DILUTION METHOD.

It is obviously desirable to know something of the limitations of any method of measurement. As is usually the case in biological work, the errors of the dilution method fall into two naturally separable groups, (1) errors of technique inherent in the method itself and (2) errors due to the experimental animal. In order to obtain some idea of the magnitude of the errors of counting involved in the present experiments, a preliminary series of counts was made upon a suspension of the red blood cells of man in a 0.8 per cent NaCl solution, to which was added enough $HgCl_2$ to prevent the disappearance of cells by hemolysis. The counts are recorded below.

TABLE III.

COUNTS MADE UPON SUSPENSION OF RED CELLS.

(1)		(2)		Average (1) and (2)	Per cent Diff. of Av.	Per cent Diff. of (1) and (2)
Cells per mm³	Per cent Diff.	Cells per mm³	Per cent Diff.			
(6880)	(10.2)	7260	2.2	7070	6.2	5.4
7620	2.3	7420	1.5	7520	0.4	2.7
7450	1.4	7530	1.5	7490	1.4	1.1
7350	2.4	7420	0.7	7385	0.9	1.0
7530	1.5	7370	2.6	7450	0.5	2.2
7640		7180		7410		6.2
AVERAGES						
7412	1.9 (3.5)	7363	1.7	7388	1.9	3.1

The count of 6,880 in the first column is obviously due to an extraordinary error, causing an error of 10 per cent between it and the succeeding count. Including this high figure, it is seen that the average error of counting is not greater than roughly 4 per cent when the number of cells actually counted is approximately 750 (double column (1) or (2) taken singly), while this error decreases to almost 2.0 per cent when the number of cells actually counted is about twice as great (columns (1) and (2) taken together). This is in accordance with the principle, emphasized by "Student" (14), that the error of counting with a hemocytometer decreases as the number of cells counted increases. It may be concluded, therefore, that the dilution method can be applied with an average counting error of not more than 4 per cent, when at least 750 cells are counted. This conclusion was checked by making

two determinations of known volumes of red cell suspension *in vitro* by the dilution method. The known and estimated suspension volumes agreed to well within 4 per cent, the mean error being about 2 per cent.

The magnitude of error in the dilution method due to the experimental animal is not certainly known. If it be assumed that the error due to counting is not greater than 4 per cent, mean experimental errors greater than this must be caused by uncontrolled changes on the part of the organism. The form of equation (1) indicates that an error of given magnitude in the initial count will cause an error of corresponding magnitude in the derived value for blood volume, when the final count is small compared to the initial count. An attempt was made to obtain some idea, therefore, of the error in the initial count due to uncontrolled changes in the organism. Two successive blood cell counts were from individuals of a series, as shown in the table below.

TABLE IV.

SUCCESSIVE BLOOD CELL COUNTS FROM FIVE DIFFERENT COCKROACHES.

Animal	Count	Cells per mm^3 Blood	Per cent Diff. Success. Counts	Per cent Diff. (1) and (2)	Total Cells Counted	Blood from Neck (Side)	Vol. Blood Sample (mm^3)
Nymph....	1st	9879	67.3	17.6	1031	R	12.8
	2nd	19900		4.6	1433	L	8.8
Nymph....	1st	23311	15.7	1.4	4200	L	39.6
	2nd	27288		1.2	2183	R	1.8
Nymph....	1st	23958	17.9	11.2	1813	L	9.2
	2nd	28669		6.0	1343	R	5.7
Adult.....	1st	18529	59.2	18.1	3074	R	20 2
	2nd	10102		6.8	1561	L	18.9
Adult.....	1st	10532	44.6	21.2	851	R	11.4
	2nd	16579		8.6	836	L	6.2
Average 1st and 2nd.		18875	40 9	9.7	1833		13.5
Average 1st.....		17242		13.9	2194		18.6
Average 2nd.....		20508		5.4	1471		8.3

Fifth vertical column: (1) and (2) refer to parallel counts made by different persons (the authors) from the same blood sample, as shown in illustrative example under Methods. The figures are differences between parallel counts, expressed as per cent of the mean value (given in column 3).

Seventh column: R = right; L = left side of neck.

These figures show that (1) the error involved in making successive total blood cell counts from a single animal is much greater (41 per cent) than the error of the counting technique (4 per cent) and is larger than the per cent difference between parallel counts. (2) The per cent difference between the two parallel counts (9.7 per cent) is greater than the error of counting. This can be attributed to the unequal cell distribution within the counting chamber due to uncontrolled coagulation in the blood sample. (3) The volume of the blood sample and the per cent difference between parallel counts are greater in the case of the first (18.6 mm^3 and 13.9 per cent, respectively) than in the case of the second (8.3 mm^3 and 5.4 per cent, respectively) of two successive samples. It is very probable that the greater per cent difference in the case of the first count is due to the occurrence of more extensive coagulation as the blood sample is being taken; since the larger the volume of the sample the longer the time required to take it from the animal and the greater the extent of coagulation. That uncontrolled blood clotting is one of the chief sources of error is illustrated by the following observation: if the blood is first drawn into the diluting pipette, as is customary in doing total counts with mammalian blood, and *then* mixed with the diluting fluid, the count is usually rendered useless because of the formation in the mixture of a coagulum of blood cells. Even when precautions are taken to prevent this by causing the blood to flow from the animal *into* a drop of diluting fluid, there is still a tendency of cells to clump; this is indicated by unevenness of distribution in the counting chamber and, at times, by the presence of a few microscopic clumps of cells. When more is known about the process of coagulation in insect blood and effective methods of preventing coagulation are at hand, this important source of error may be greatly reduced and the accuracy of the dilution method thereby increased.

One may conclude that the differences between parallel counts (5th vertical column, Table IV) are due largely to clotting. These counts are made upon samples from the same diluting pipette. Much greater errors are involved in making counts on different samples from the same animal (4th column, Table IV). Here are included not only errors due to coagulation in the blood sample but also any errors of cell redistribution in the organism as well as errors due to changes in the total number of circulating cells. The latter may possibly occur due to a liberation of previously stored cells or to a rapid formation and liberation of new cells into the blood stream. The mammalian spleen is not only recognized as being a storage place for blood cells but has been shown to pour out the stored corpuscles into the circulating blood, producing a quite appreciable alteration in total cell counts (12). It is not entirely improbable, therefore, that an increase in the total blood cell count in the insect may be due partially, at least, to additional cells entering the blood. The alternative of cells being removed from the blood is a factor requiring consideration, especially with reference to clotting at points of injury, produced for example in taking the initial sample or in amputating the leg and inserting the injection canula. Alterations in cell concentration may also result from the addition of

water to or the removal of water from the blood by other parts of the animal, for example, the gut. Although it is not improbable that readjustments in the organism such as these actually occur, no experimental evidence of their occurrence other than the presence of large experimental errors has been obtained in the course of the present work.

SUMMARY.

1. A corpuscle dilution method of determining the total volume of circulating blood in the cockroach, *Periplaneta fuliginosa* Serville, has been described.

2. A modification of the absorption method of Richardson, Burdette and Eagleson has been described.

3. On the basis of 18 determinations by the dilution method, the mean value for the total blood volume of *P. fuliginosa* is 0.035 cc. or, expressed differently, 0.069 gms. per gm. body weight.

4. On the basis of 20 determinations by the filter paper method the mean blood volume is 0.027 cc. or 0.047 gms. per gm. body weight.

5. These figures indicate that the cockroach body contains relatively less blood than do the larval forms used by other investigators for blood volume determinations.

6. It is noted that the errors involved in the dilution method fall into three groups: (a) those inherent in the counting technique, (b) those due to uncontrolled blood coagulation and (c) those due to other alterations in the experimental animals.

7. It is shown that in the present experiments errors of determination due to (a) amount to not more than 4 per cent, those due to (b) average about 14 per cent (Table IV, column 5) and those due to (c) average as much as 40 per cent.

8. It is suggested that the magnitude of the errors of groups (c) and, especially, (b) may be greatly reduced by more effective methods of controlling blood coagulation.

9. The results obtained show that the average blood cell count of *P. fuliginosa* is approximately 30,000 cells per mm^3 of undiluted blood.

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A NEW BARINE CURCULIONID INJURIOUS TO SUGARCANE IN LOUISIANA WITH SYNOPSES OF ANACENTRINUS AND OLIGOLOCHUS (COLEOP.)

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The new curculionid herein described appears to have been first noticed in April, 1910, at Berwick, La., by D. L. Van Dine and was reported in 1912 by T. E. Holloway, who collected specimens on sugarcane stubble at New Orleans, La. The same species was taken by T. H. Jones in 1922 at Baton Rouge, La., by J. W. Ingram in 1929 at Houma, La., and by W. E. Hinds and B. A. Osterberger in 1931 at Arnaudville, Baton Rouge, and many other localities in Louisiana. The weevil is evidently closely related to several of the forms that Casey referred to *Anacentrus*, and it was under the name *Anacentrus* sp. that Ingram and Holloway published their observations on the work of the species (Journ. Eco. Ent., vol. 23, 1930, pp. 832–833). It being desirable to have a definite name for the weevil, and also to fix the limits of the genera involved, the writer undertook a brief systematic study which, unfortunately, has shown the need of certain changes in the nomenclature before the new species can be properly incorporated in the group. The facts bearing on the case are as follows:

In his 1892 revision of the Barinae, Casey used *Limnobaris* in the broad sense to include several well defined species groups, and in the same paper he erected the new genus *Oligolochus* for the "? *Zygobaris*" *convexus* of Leconte 1876. Casey did not have specimens of *convexus*, but based the characterization of *Oligolochus* on published statements and on manuscript notes. In 1920, Memoir 9, Casey proposed a new generic name for each of the species groups of the old *Limnobaris;* of these segregates only the one named *Anacentrus*, with designated genotype *Limnobaris bracatus* Csy. 1892, concerns the present question. A comparison of *convexus* Lec. and *bracatus* Csy., the genotypes of *Oligolochus* and *Anacentrus* respectively, shows that these two species are close relatives and therefore, if we

are to avoid the creation of a new genus for nearly every species, that *Anacentrus* 1920 must be treated as a synonym of *Oligolochus* 1892.

However, the simple substitution of *Oligolochus* for *Anacentrus* does not settle the matter satisfactorily, for the species related to *bracatus and convexus* form a natural group that differs in several respects from the other *Anacentrus*, including the sugarcane species. The course that seems to stand the best chance of nomenclatorial permanence is to restrict *Oligolochus*, with synonym *Anacentrus*, to *bracatus*, *convexus*, and allies, and to place the remainder in a separate genus. For this genus the new name *Anacentrinus* is here proposed.

As to its scope, *Anacentrinus* will include, in addition to the bulk of the *Anacentrus* species, the North American *Centrinogyna subaequalis* Csy. and *Oligolochus longipennis* Linell, the Central American *Anacentrus politus* and *guatemalensis* of Casey, the Peruvian *Eumycterus saccharidis* Barber, and perhaps also a few of Champion's Central American *Limnobaris*. Only the three exotic species specifically mentioned are treated in the following keys. The keys themselves are unsatisfactory in several places because of the trivial or gradational nature of the alternatives; but this difficulty can not be altogether overcome in a group like the present one where the specific distinctions are indefinite and the individual variation considerable.

For aid received I wish to make special acknowledgment to Nathan Banks, who furnished information concerning types in the Leconte collection; to W. S. Blatchley, who loaned a cotype of his *Oligolochus vicarius;* to J. W. Ingram, B. A. Osterberger, and W. E. Hinds, who supplied most of the specimens of the new species; and to Dr. Hinds for suggesting and making arrangements for the publication of these notes preceding a paper by Hinds and Osterberger dealing with the occurrence and work of this species. The figures were drawn by Eleanor Armstrong Carlin.

Oligolochus and *Anacentrinus* are distinguished from the rest of the old *Limnobaris* series by these characters in common: Rostrum distinctly arcuate, subequally so in both sexes, the apex often flattened, rising from head at an obtuse but generally evident angle; antenna inserted slightly to far beyond middle of beak, first funicular segment conspicuously longer than

second, club oval; prosternum of male without pits or spines; color more or less reddish in most species; body short and broad to elongate-subparallel; sculpture of elytral intervals coarse to fine but always consisting of one or two rows of sharply defined punctures; vestiture of dorsum variable in size and distribution, hair-like to scale-like, often condensed in certain areas, never at the same time broad and forming a complete and even surface coating.

The two genera are separated thus:

Basal margin of elytra notched opposite 5th stria, the 5th and 6th striae confluent at base next to the rather prominent humeral callus; pronotal base with a well-developed median lobe (except in *minuens*); body more convex, stouter, more strongly narrowed behind; rostrum long, flattened toward apex; prosternum strongly constricted in front, the transverse groove deep and entire; metasternum short, the distance between 2nd and 3rd coxae subequal to or only slightly more than the distance between 2nd coxa and tip of expanded base of metepisternum; elytral striae coarse; dorsal vestiture always scale-like, dense along side of pronotum, on elytra rather abundant around periphery but scanty or wanting at middle, or, if not so arranged on elytra, the pronotum has an impunctate lateral area,

Oligolochus Csy. (*Anacentrus* Csy., sens str., new synonym)
Genotype, ? *Zygobaris convexus* Lec.

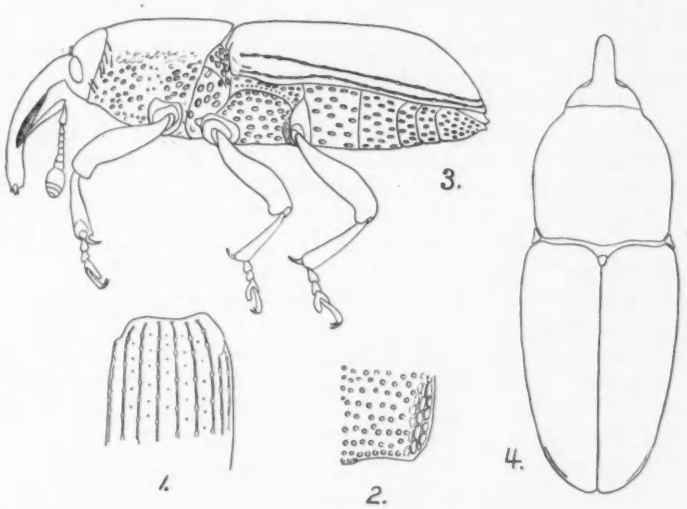
Basal margin of elytra not notched, the humeral callus feeble, the 5th and 6th striae terminating independently at base; dorsal vestiture scanty and hair-like in typical forms, or, if scale-like, not concentrated around the periphery of the elytra, the pronotum never with impunctate lateral area; other characters variable,

Anacentrinus new genus (*Anacentrus* Csy., in part)
Genotype, *Anacentrinus subnudus* n. sp.

Anacentrinus subnudus, new species.
(Text Figs. 1–4.)

Length, 2.5 to 3.1 mm.; width, 0.95 to 1.25 mm. Elongate, somewhat flattened, shining, color generally reddish, rarely almost entirely piceous black. Sides of pronotum and base of elytra with sparse, yellowish-brown, hair-like scales, the base of rostrum above and anterior margin of prothorax at sides with a few longer, suberect hairs. Rostrum in side view moderately arcuate, length of arc nearly equal to length of pronotum, rather strongly discontinuous with head in profile, above finely punctate, the punctures coarser and often more or less longitudinally confluent at sides; antennae inserted at apical one-third in male, slightly farther back in female, scape a little shorter than funicle, the latter with first segment about twice longer or somewhat less, than second, second longer than third, third to seventh transverse and

progressively broader, club oval, its first segment comprising a little more than half the entire mass. Head finely alutaceous and punctulate, eye narrow. Prothorax as long as wide or slightly wider than long, sides feebly rounded or nearly straight and subparallel in basal two-thirds or three-fourths, thence convergent to the apex, which is unconstricted or slightly and narrowly constricted; pronotum with feeble basal median lobe, the surface with rather small punctures that vary considerably in density, but are never crowded, and for the most part distinctly separated by broad, flat interspaces, the punctures longitudinally confluent along side margins, median smooth line obsolete;



Anacentrinus subnudus n. sp.

Fig. 1. Basal section of right elytron.
Fig. 2. Right basal quarter of pronotum.
Fig. 3. Side view of adult.
Fig. 4. Dorsal view.

propleural punctures elongate and close-set (except for a nearly smooth line directly above coxa) but not forming distinct rugae. Elytra little wider than prothorax, vestiture distinct at base, visible though much finer near apex, the disk appearing glabrous, striae rather fine, one-third or less width of intervals, finer toward apex, distinctly punctate, the punctures smaller or evanescent apically; intervals flat or slightly convex, each with a row of small, distant punctures which are larger near base. The elytral punctures, both in striae and on intervals, are always much smaller than the pronotal punctures. Venter rather strongly punctate, the punctures smaller along middle of metasternum and first four abdominal sternites, coarse and dense on mesopleura; vestiture exceedingly fine, hardly visible except on last three abdominal

sternites. Anterior coxae separated by slightly less than the width of a coxa.

Type Locality.—Baton Rouge, Louisiana (T. H. Jones); type and 11 paratypes (T. H. Jones, 2; B. A. Osterberger, 9).

Other localities (paratypes): Arnaudville, La. (B. A. Osterberger, 3); Houma, La. (J. W. Ingram, 8; Federal Horticultural Board No. 95123, 1); Audubon Park, New Orleans, La. (T. E. Holloway, 1).

Tpye and paratypes.—Cat. No. 43813, U. S. N. M.

In one specimen from Baton Rouge the 3rd elytral interval has the longer basal hairs extended along its entire length. Occasionally the pronotum shows indications of a narrow, indefinite impunctate line along the middle. The color varies from entirely pale reddish to almost completely piceous black, the darkest specimens with only the legs and a large median area on each elytron obscure reddish.

A. subnudus has been found in the field associated with *A. deplanatus* Casey; the latter species can be recognized by its normally black color and duller surface luster, by its more or less concave elytral intervals with their punctures unusually large and with their setae fine but equally developed throughout, by its more densely punctate pronotum, etc.

The following key gives the differences between *subnudus* and *planiusculus* Csy. Though the two species are closely allied, they could not be considered identical on the basis of the available material which, except for a single specimen from Brownsville, Texas, shows no clear evidence of intergradation. In the specimen referred to the elytral striae are punctate as in *subnudus*, but the other characters point to *planiusculus*. This example is tentatively referred to the latter species.

KEY TO SPECIES OF *Anacentrinus*.

1. Metepisternum with minute widely separated seta-like scales; dorsal vestiture yellowish or brownish (paler in the black species), fine, inconspicuous (except in *saccharidis*), sometimes hardly visible, never composed of broad scales, the pronotum with sparse, hair-like, seta-like, or very slenderly oblong scales which are generally more numerous toward sides, but are always well separated and never forming a sharply defined lateral stripe; color black or reddish, the elytra relatively longer and more oblong, the body less convex, often subdepressed; base of pronotum subtruncate or at most with a feeble median lobe; metasternum longer, distance between 2nd and 3rd coxae distinctly more than one-fourth greater than distance between mid-coxa and tip of expanded base of metepisternum (except in *denudatus*); rostrum subcylindrical, or slightly flattened apically (strongly flattened in *nasutus* group) 2

Metepisternum with true scales, closely placed (sparse in the two Guatemalan species); dorsum with elongate-triangular or oblong, whitish scales, those on pronotum forming a distinct lateral stripe; color generally reddish, the elytra shorter and more strongly narrowed behind, the body more convex; pronotal lobe well developed in most species; metasternum a little shorter; rostrum almost always distinctly flattened toward apex (subcylindrical in the two Guatemalan species)... 10

2. Male without denticle on first abdominal sternite; color more or less reddish (except in *deplanatus*, which has dorsal vestiture plainly visible); elytra very rarely with a faint transverse depression at basal third; size generally less than 3.25 mm.; rostrum subcylindrical or slightly flattened apically, more abruptly discontinuous with head in profile, funicle of antennae distinctly stouter distally, length of first segment little more than depth of beak near apex..... 3

Male with a small denticle or tubercle on middle of first abdominal sternite next first suture; color black, vestiture on disk of elytra generally minute; elytra nearly always with a shallow, transverse depression across basal third; size larger, rarely as little as 3.25 mm.; rostrum longer, thinner, distinctly flattened toward apex; first funicular segment very slender, its length considerably greater than depth of beak near apex..... 8

3. Color black, surface finely alutaceous, elytral intervals more or less concave and with punctures that are unusually large, often two-thirds or more the width of interval, striae coarse; pronotal vestiture denser at sides as usual and often also extending inwardly to near middle; elytra with regular rows of minute but distinct seta-like scales. Length 2.25 to 3.25 mm. Washington, D. C., Southern Illinois, South Dakota, Missouri, Kansas, Texas, Arkansas, Louisiana, Mississippi; Sixty specimens..... **deplanatus** Csy. (**tabidus** Csy., new synonym)

Color predominantly reddish as a rule (*saccharidis* is sometimes piceous black); elytral intervals flat and with smaller punctures; pronotal vestiture confined to margins..... 4

4. Size larger, 3 to 4 mm.; each elytral interval with a regular row of suberect, close-set, short and slender but conspicuous scales; pronotal vestiture rather more condensed than usual along sides; Peru (Pomalca, 5 specimens; Valle Chicama, J. Wille, 13 specimens); Ecuador (Guayaquil, 2 specimens),
saccharidis Barber (Proc. Ent. Soc. Wash., Vol. 29, 1927, p. 149)

Length seldom over 3 mm.; elytral setae minute or scarcely visible on disk, longer at base and apex; species north of Mexico..... 5

5. Body stouter, the prothorax about six-sevenths as long as broad, the pronotum evidently convex, alutaceous, sparsely and somewhat unevenly punctate; length about 3 mm. Florida; 2 specimens, **denudatus** Csy.

Prothorax a little less transverse and often as long as wide, the punctures of pronotal surface normally even, the median line of pronotum in side view nearly flat; average length less than 3 mm..... 6

6. Body slender, elongate-subparallel, the pronotum as long or a little longer than wide, elytral striae coarse, the intervals each with a row of strong, close-set punctures which are deep entirely to apex, elytra in type specimen (Oregon) with a vague transverse depression across basal third, this wanting in a California specimen. Length 2.5 to 3 mm. Pacific Coast. Two specimens..... **angustus** Csy.

Body evidently broader at humeri and more narrowed posteriorly; punctures on intervals distinct at base, but becoming smaller and shallower, sometimes disappearing toward apex. Average length about 2.75 mm. Gulf region..... 7

7. Elytral striae finer, the first near base about one-third or one-fourth as wide as second interval, the strial punctures very evident and distinctly encroaching on the intervals; pronotal punctures smaller or sparser, often separated by several times their own diameter, the median smooth line obsolete; first funicular joint shorter; propleural punctures not forming rugae. Louisiana..... **subnudus**, n. sp.

Elytral striae coarser, the first near base one-half or more width of second interval, the strial punctures on disk absent or small and at bottom of groove, very little if at all encroaching on interval; pronotal punctures rather dense, the smooth median line distinct; first funicular segment longer, twice or more length of second; propleura rugose. Texas; 4 specimens.....**planiusculus** Csy.

8. Elytra polished, the transverse depression across basal third almost always distinct, intervals flat, often with evident row of fine, seta-like scales; hairs on side of pronotum fine but generally distinct; body less convex; length 3.25 to 4.5 mm. Utah, Nevada, California; "Texas" (subcrenatus Csy.); 40 specimens.....**nasutus** Lec.
(**apertus** Csy., **subcrenatus** Csy., **franciscus** Csy., new synonyms)

Elytra finely alutaceous, basal depression feebler, intervals more or less concave, dorsal vestiture hardly visible. Middle States..... 9

9. Length 3.25 to 4 mm., the impression across base of elytra feeble but present. Wisconsin, Iowa, Minnesota; 11 specimens.....**oblitus** Csy.

Slightly larger and stouter, the elytral impression obsolete. (Doubtfully distinct from *oblitus*). Winnipeg, Manitoba,
subaequalis Csy. (**Centrinogyna subaequalis** Csy.)

10. Rostrum not at all flattened apically; pronotum with large sparse punctures, median smooth line obsolete; metepisternum with a few scattered scales near apex, its vestiture otherwise of minute setae; Guatemala.....11

Rostrum evidently flattened toward apex; pronotum with smaller, generally close-set punctures, the smooth median line generally distinct; metepisternum with scales throughout its length, these narrower and somewhat seta-like in *longipennis;* north of Mexico.....12

11. Body narrow, prothorax nearly as wide as elytra, the latter with sides subparallel in basal two-thirds, the disk with a broad, vague flattening across basal one-third. Length 2.6 mm.; width .75 mm. One specimen,
politus Csy. (Memoir 9, 1920, p. 470)

Body broader, the elytra more narrowed posteriorly and not flattened across disk, striae coarser, intervals with coarser punctures. Length, 3 mm.; width 1.15 mm.....**guatemalensis** Csy. (Memoir 9, 1920, p. 470)

12. Body broader, the sides of prothorax strongly convergent forward, the median smooth line of pronotum absent; striae and intervals strongly punctate; length 3 mm. (Leconte). Texas. (Species not seen),
punctiger Lec.

Median smooth line of pronotum distinct (except in *blanditus* which has sides of prothorax at most feebly convergent and intervals finely punctate).....13

13. Elytral striae coarse, not punctate, or with punctures small and at bottom of groove, at middle of disk one-half or more width of interval, intervals each with a row of narrow, close-set scales, those on first and second finer, those on third coarser or more numerous; pronotal punctures coarser, median smooth line distinct; male with a small spot or tuft of more densely placed scales on first abdominal sternite on edge of basal concavity near first suture..... 14

Elytral striae finer, not more than one-third or one-fourth width of interval, distinctly punctate towards base, the punctures encroaching on edge of interval; intervals 3, 5, 7, and 9 with a few widely scattered scales; pronotal punctures finer, the median smooth line more or less effaced; male abdomen without spot of scales as above.....16

14. Propleura coarsely and completely strigose; metepisternum at middle with a single row of narrow scales; prothorax with sides subparallel basally, subtubulate at apex, the transverse groove deeper, especially across prosternum; metasternum scarcely longer than the longitudinal diameter of mid-coxa; elytral scales narrower and seta-like. Length about 3 mm. Texas, Oklahoma. Five specimens,
longipennis Linell (**oklahomae** Csy., new synonym)

Propleura not strigose, though a few of the punctures may coalesce here and there; metepisternum with a double or triple row of scales at middle; metasternum a little longer; sides of prothorax more gradually narrowed to apex; elytral scales heavier.....15

15. Third elytral interval not broadened in basal half and with a single regular row of punctures; scales slightly broader; prothorax narrower, with sides a little more evidently convergent forward; piceous black. Length 3 to 3.8 mm., Florida; 5 specimens.....**limbifer** Csy.

Very close to above, but third interval a little broader at base where the punctures are irregular. Color reddish. Length 3.2 to 3.6 mm. Colorado; 2 specimens.....**decorus** Csy.

16. Size 3.7 mm. Second elytral interval much broader at base and here with a confused triple row of fine punctures; pronotum more convex; rostrum less arcuate, more nearly continuous with head in profile. Austin, Texas; 1 specimen.....**validulus** Csy.

Size 2.5 to 3.25 mm.; second interval less widened basally, here with a confused double row of punctures; pronotum feebly convex. Texas (Columbus, Victoria, Brownsville, Austin, San Antonio), Louisiana (Tallulah); 20 specimens..**blanditus** Csy. (**subtropicus** Csy., new synonym)

KEY TO SPECIES OF *Oligolochus*.

1. Elytra largely bare of true scales, the few that are present arranged in a widely spaced row along third interval, a patch at base of fifth, and a few scattering ones along seventh; pronotum with an impunctate area along middle of side next to inner edge of the lateral stripe; prothorax longer compared to elytra, the ratio being about 5 to 8; elytra reddish, rarely piceous black; body very strongly convex; propleura strigose; base of abdomen of male with an abrupt and deep depression which is densely set with erect, brownish pile. Length 2.5 to 3.5 mm. Massachusetts, New Jersey, District of Columbia, Maryland, Virginia, Missouri, Kansas, Iowa; 16 specimens.....**bracatus** Csy. (**robustus** Linell)

At least the periphery of elytra scaly, closely so as a rule; prothorax a little shorter; pronotum without impunctate lateral area (except *convexus*); abdominal depression of male not pilose..... 2

2. Color black or piceous black, the scales usually white, the median denuded area of elytra rather sharply defined; elytral intervals, except the third in whole or part and the fifth toward base, with a single regular row of punctures, the sculpture not becoming rough or subrugose toward sides; scales on third interval behind middle concolorous with the others and not conspicuously larger or more crowded than elsewhere; side of rostrum generally plane or convex between tip of scrobe and apex; southeastern United States..... 3

Elytra obscure reddish with a darker median cloud, elytral scales mostly brownish, narrowly oblong, moderately abundant (though smaller) on the median area so that the subdenuded spot is not at all well defined, the scales on third interval behind the middle rather strongly differentiated by reason of their larger size and paler color; elytral intervals more coarsely and confusedly punctate, the punctures on at least the third and fifth intervals in a confused double row, in a more or less staggered single row on the other intervals, the sculpture becoming somewhat rough or subrugose toward the sides; side of rostrum generally with a groove from tip of scrobe nearly to apex; southwestern United States..... 6

3. Pronotum with an impunctate area toward middle of sides; punctures on pronotum and on propleura rather shallow; length 2.5 mm. Florida, **convexus** Lec.

Pronotum without impunctate lateral area..... 4

4. Body narrower, prothorax less transverse (ratio of width to length about 8 to 7), longer compared to elytra (ratio about 21 to 34); length 2.18 mm.; width 1.1 mm. North Carolina (So. Pines).....**ovulatus** Csy.

Body broader, the prothorax a little more transverse; length 2.3 mm. or longer..... 5

5. Propleural sculpture unusually shallow; pronotal punctures, ♂, large and rather superficial, leaving a broad median line smooth; elytral scales white, 3 or 4 times as long as broad; length 2.3 to 3 mm. (Blatchley). Florida (Dunedin).....**vicarius** Blatchley

Propleural sculpture normally deep; pronotal punctures, ♂ and ♀, small, dense, median smooth line narrow; elytral scales sometimes yellowish, two or three times as long as broad; length, 2.6 to 2.8 mm. Indiana, Missouri, Tennessee, Alabama, North Carolina.....**ornatus** Csy.

6. Size larger, about 3 mm.; pronotum with distinct median basal lobe; sides of prothorax generally slightly but visibly narrowing from a little in front of base. California (Fresno and Yuma); 7 specimens..**seclusus** Csy.

Smaller, about 2.5 mm.; pronotal lobe obsolete; sides of prothorax subparallel in basal three-fourths; vestiture above and below a little coarser. Arizona. (Casey collection; 1 specimen).....**minuens** Csy.

NOTES ON THE NEW SYNONYMY IN ANACENTRINUS.

deplanatus Csy. (*tabidus* Csy.); *tabidus* is a small male of *deplanatus*. The name *deplanatus* is hereby selected to represent the species in spite of the one-page priority of *tabidus*.

nasutus Lec. (*apertus* Csy., *subcrenatus* Csy., *franciscus* Csy.). The differential characters mentioned by Casey reappear here and there throughout the series of 40 or more specimens of *nasutus* examined. I can find no way to distinguish more than one species. The Texas locality record of *subcrenatus* needs confirmation.

longipennis Linell (*oklahomae* Csy.). The fact that Linell's species was unknown to Casey probably explains the duplication here. The type specimens agree in all essentials.

blanditus Csy. (*subtropicus* Csy.); *subtropicus* is an old, blackened and abraded specimen of *blanditus*.

BOOK NOTICE

MY NATURE NOOK, by W. S. BLATCHLEY, pp. 1–302 with 15 plates. The Nature Publishing Co., Indianapolis, Ind.

This is a diary of Professor Blatchley's winters at Dunedin on the west coast of Florida. It is packed from cover to cover with observations on the plant and animal life of the Florida coast. It has no formal organization into chapters, but rambles along from date to date, observations of nature interspersed with philosophical reflections. Even such a volume has to have a key and this is found in the index, which is an alphabetical list of the plants and animals mentioned in the body of the work.

After conscientiously trying to read the many hastily written volumes on fundamental biological problems that are written to help biologists achieve a more nearly living wage, the writer has thoroughly enjoyed a book that is written for the love of the subject and the love of writing. It lies on the desk next the easy chair and is dipped into a page or two at a time, in those moments of indecision and relaxation when one hesitates to decide which of several pressing things has to be done next. We recommend it for those nature lovers who still possess the remnants of a soul that from time to time demands nurture.

—C. H. K.

SUGARCANE ROOTSTOCK WEEVILS.

W. E. Hinds and B. A. Osterberger,
Louisiana Experiment Station.

EARLIER RECORDS.

In December 1912, Mr. T. E. Holloway recorded (1, 2) the discovery on April 28, 1910, by D. L. Van Dine at Fairview Plantation, Berwick, La., of a small weevil working in the rootstocks of cane below the surface of the ground. Later Mr. E. R. Barber found what seemed to be the same species in cane at the Audubon Park Sugar Experiment Station, and Mr. Holloway reports finding it also at Brownsville and Donna, Texas, and at Donaldsonville and Franklin, La.

Since those earliest records this weevil seems to have attracted little attention until very recently when in a brief article Ingram and Holloway (3) reported finding some infestation in all fields examined and in some cases the injury to stands of stubble cane was severe, especially because of the extensive destruction of eyes in the rootstocks.

Mr. W. G. Taggart also states that he has seen the work of these weevils at Audubon Park and at other places but only recently does anyone seem to have considered the weevil as a pest of probably serious importance.

RECENT INVESTIGATIONS.

Early in June 1931 a complaint was received at the Louisiana Experiment Station regarding the failure to get a stand of first year stubble on a large area of P. O. J. 213 cane at Arnaudville, La. An investigation was made by the Station entomologists on June 6 and there was found to have been a heavy infestation by a small weevil species in practically every rootstock where the cane had failed to grow, but at that date, in comparatively limited examinations on dead stubble, only two small larvae of the weevil were seen. On this plantation the first year stubble cane was completely killed out on about 10 acres and the stand was badly broken on some 90 acres more. The stand and growth of the cane planted in the fall of 1930 was

as good here in June as in other localities and later a good crop was harvested therefrom.

In September an infestation by these weevils was found in stubble cane of P. O. J. 36 variety growing opposite Baton Rouge along the west bank of the Mississippi River at Poplar Grove Plantation, Anchorage. Subsequent examinations revealed its presence at the Sugar Experiment Station, Cinclare, Plaquemine and, in fact, in every field that we have examined thus far in any part of the Cane Belt. These weevils now appear to be very widely distributed. In the fall examinations living stages were found in great abundance representing all stages except the egg (Pl. I., Figs. 1 to 6). The larvae present were of all sizes from very small to full-grown. Pupae and adults were quite numerous.

There appeared to us to be a wide variation in the structural appearance and color of the adults found. Some were quite black while others were "reddish brown" in color. In order to secure an authoritative determination a number of specimens were sent to the U. S. National Museum, where Mr. L. L. Buchanan found and reported two distinct species instead of one. The less numerous black species was determined as being *Anacentrus deplanatus* Csy. and the more common brown species as of the same genus but apparently a new species. Material was requested for further study and an abundance of various stages was supplied. Mr. Buchanan's study has led him to make a revision of the genus *Anacentrus* with the erection of a new genus *Anacentrinus* (of which the new species *A. subnudus* is made the genotype).

Mr. A. F. Satterthwait, of the U. S. Bureau of Entomology, has kindly given us a copy of the records on file in the Bureau regarding various species of *Anacentrus* with all determinations as made by Mr. Buchanan. From these records it is quite evident that *A. deplanatus* is the most commonly known species of this genus and that it is distributed from Louisiana to Missouri and Kansas, at least. It has been recorded heretofore only on "wild grasses" and especially the species *Echinochloa crus-galli* (barnyard grass or cockspur grass), where "the larvae occur close to the skin of the root crown or taproot where the rootlets arise." This wild grass grows commonly in cultivated ground over the whole state of Louisiana. The transfer of *A. deplanatus* from this possible native source to

cane would therefore be easily accomplished and not at all surprising. It is quite possible that it occurs on other species of native grasses also.

The typical work of the two species appears to occur together on sugarcane (Pl. I, Figs. 1, 5, 6) and possibly they have other host plants in common. We have not learned as yet to distinguish the work or the immature stages of these two closely related species.

OTHER HOST PLANTS.

In addition to sugarcane this new weevil has been found breeding in the roots of corn and to a limited extent in sorghum and also in "bull grass" (*Paspalum boscianum*). In the bull grass growing in uncultivated areas the following stages were found during the early part of December 1931, at Baton Rouge:

TABLE I.

ANACENTRINUS STAGES IN BULL GRASS.

LOCATION	ROOTSTOCKS		WEEVIL STAGES TOTAL	NUMBER STAGES PER STUBBLE
	Number Examined	Per cent Attacked		
West of L. S. U. Stadium...	100	73	58	0.58
Field uncultivated 6 years..	120	61.7	41	0.34

The foregoing figures show that there is a very large population of these weevils outside of cane fields. Limited examinations of the roots of various other plants have included soybeans, cowpeas, wild verbena and some other wild grasses, but thus far these have not been found infested.

ABUNDANCE IN SUGARCANE.

During the fall of 1931, from October 28 to December 15, examinations revealed that a very heavy infestation exists in many widely separated localities. The extent and seriousness of this is indicated in the following typical set of records (*see* Table II, following page) which were all made on P. O. J. 213 stubble cane.

TABLE II.

ROOTSTOCK WEEVILS IN 213 STUBBLE.

	BATON ROUGE SUGAR STATION SECOND YEAR STUBBLE	PLAQUEMINE ISLAND PL'N. FIRST YEAR STUBBLE	ARNAUDVILLE SINGLETON'S	
			First Stubble	Dead 1930 St.
Rootstocks:				
Number Examined	1,000	640	24	36
Infested	957	640	24	34
Per cent Infested	96.0	100.0	100	94.0
Eyes:				
Total	5,216	3,348	191	....
Number Bad	1,611	1,590	77	....
Per cent Bad	30.8	47.5	40.3	....
Stages:				
Total	1,694	2,214	123	32
Number Dead	167	70	2	2
Per cent Dead	9.2	3.1	1.6	6.2
Average Number per Rootstock	1.7	3.4	5.1	1.1

The greatest number of stages yet found in 1 rootstock (about 8 inches long) is 23.

OCCURRENCE IN VARIOUS SOIL TYPES.

At Baton Rouge the soil type is mainly Mississippi Alluvium, first bottom soil, including Yazoo and Sharkey mainly, while the second bottom or bench land is a silt loam. At Plaquemine the soil is a still more sandy Yazoo type. At Arnaudville a Red River sediment, mainly Yahola, predominates. In other localities found quite heavily infested, Coastal Prairie Sediments predominate, with Lintonia Silt Loam common. It seems thus far that no soil type commonly producing cane is entirely free from their presence, although the ratio in abundance of stages per rootstock, as shown in Table 2, is: Baton Rouge 1, Plaquemine 2 and Arnaudville 3.

INFESTATION OF PLANT CANE.

Examinations of cane at the end of its first year of growth have shown that a heavy infestation may occur therein although the stand and growth may appear to be "normal." However is such fields, as in stubble cane, there may be found many stalks which appear to be somewhat stunted in growth and

which have very weak root systems and show heavy infestations in their rootstocks. It has been found generally that the percentage of eyes germinating in fall planted cane ranges usually between 15 and 25%. How much of this loss of eyes is due to the work of *Anacentrinus* is a question to be studied further but that some of it is due to them is already proven.

In a field believed to be infested and where corn and soybeans had been grown in 1931, a number of pieces of cane planted in October were dug up and examined on December 17. The work of *Anacentrinus* on and around the eyes was easily and positively recognizable. This happened to be P. O. J. 213 plant cane. In the small lot examined were a total of 41 eyes, of which 8, or almost 20%, were already destroyed by *Anacentrinus*. Three stages, including 1 each of larva, pupa and adult, were taken in or very close to dead eyes. Two-thirds of the short pieces of cane examined had been attacked to some extent and the attack was continuing.

HIBERNATION.

The fall of 1931 has been unusually warm with no killing frost in the Cane Belt up to December 31st. and a minimum temperature of 34° F., or higher. Under these conditions we have found no sign of hibernation of *Anacentrinus* up to this late date. The growth of larvae and pupation are continuing steadily and adults are quite numerous and very active. Mating appears to be common, but no oviposition has yet been found through these fall months.

COMMON NAMES PROPOSED.

No mention of such a weevil species has been found in the literature of other cane growing countries. On account of the characteristic of attacking mainly the rootstocks of cane, and other less important host plants, and the confusion with "sugarcane weevil" which is already used for an entirely different weevil species in some other countries, we are inclined to suggest for these two species together the common name "Sugarcane Rootstock Weevils," with the two species distinguished as "black" for *Anacentrinus deplanatus* Csy., and as "brown" for the new species now described as *A. subnudus*, Buch.

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(2) Field Observations on Sugarcane Insects in the United States in 1912. Cir. 171, Bur. Ent. (March 21, 1913).

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EXPLANATION OF PLATE

Anacentrinus subnudus Buch. Stages and Typical Work on Sugarcane.

Fig. 1. Cane rootstock infested, external appearance; a, Bud, or eye, apparently sound; b, Eye destroyed; c, Emergence holes of weevils.

Fig. 2. Larvae.

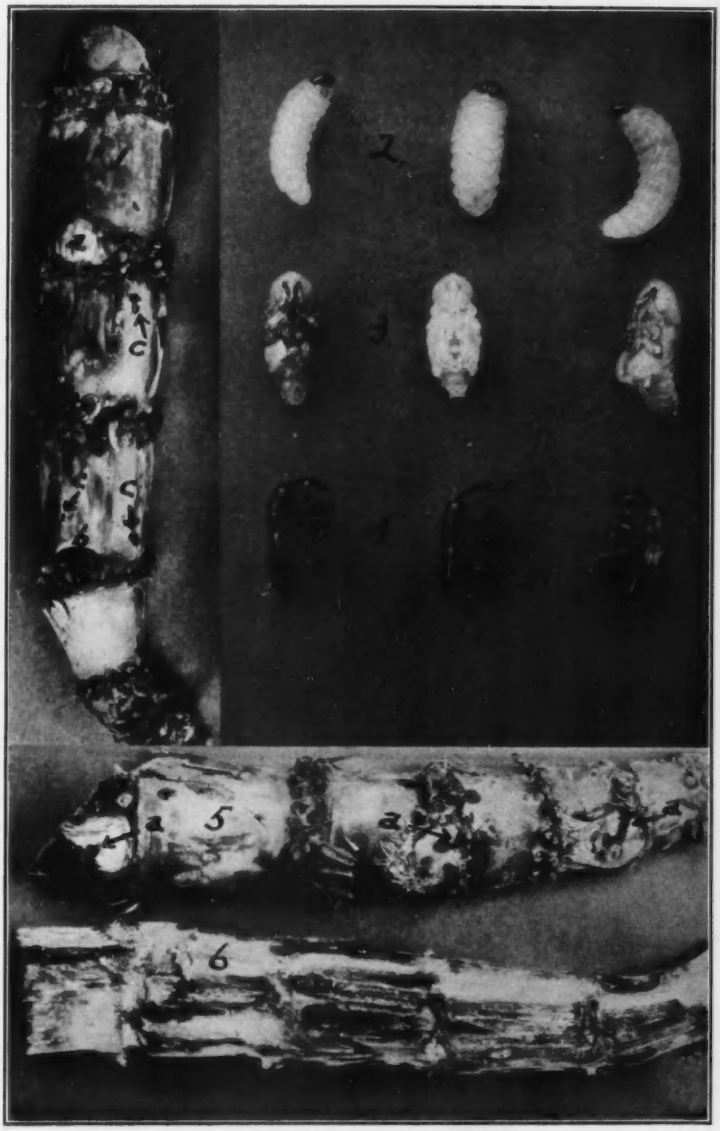
Fig. 3. Pupae.

Fig. 4. Adults.

Fig. 5. a, Three eyes destroyed.

Fig. 6. Rootstock split, showing internal work.

All original. Figs 1, 5 and 6, × 1/1; Figs. 2, 3 and 4, × 7/1.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LATE FALL ACTIVITY AND SPRING EMERGENCE OF THE HESSIAN FLY IN IOWA.[1]

C. J. DRAKE AND G. C. DECKER.

The unusual weather conditions which prevailed in Iowa during the summer of 1930 produced changes and irregularities in the seasonal development of the Hessian fly heretofore unrecorded in the state. In 1922 the Iowa Agricultural Experiment Station began an extended study of the Hessian fly. Since then field stations have been established each fall to make observations on the emergence of the flies so as to predict the fly-free date (4) for sowing winter wheat. During most of this period biotic conditions were about normal and, although slightly unseasonal dry and wet spells produced light secondary waves of spring and fall emergence, the two-brood cycle has largely prevailed. In 1930, however, the summer and fall months were unusually dry with only local rains slightly breaking an unprecedented drought. Aside from the general retardation of development produced by the drought, the rainfall in some localities occurred at favorable periods to cause an untimely wave of early emergence during late summer and early fall. In addition, the usual emergence of the fall brood was slightly delayed and incomplete and later followed by a large supplemental brood of flies during the first twenty days of October, the offspring of which continued to develop throughout the rest of the winter. This late supplementary brood issued largely from the late summer and early fall broods and, to a lesser extent, from the first larvae completing development of the normal fall brood together with a few stragglers or hangovers from the spring brood.

Larrimer (1), Cartwright (2) and Parks (3) have reported instances of delayed emergence from the normal fall brood of flaxseeds in old wheat stubble in Ohio, Indiana and Illinois. McColloch (5) has also recorded midsummer and supplemental fall broods in Kansas and the finding of a full grown naked larva in the field on February 24, 1916.

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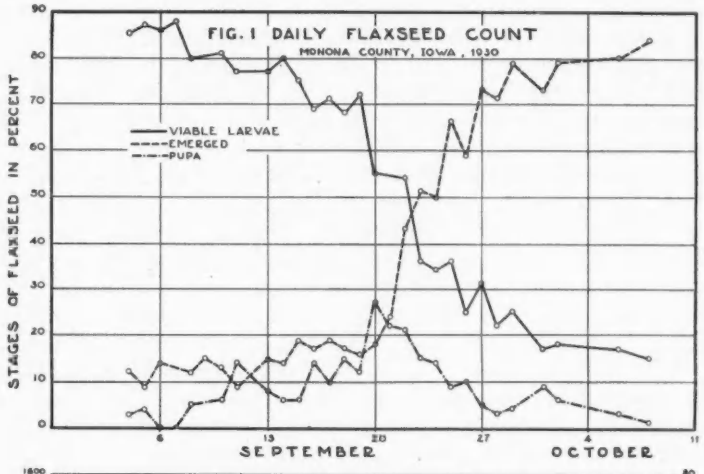
[1]Journal Paper No. B25 of the Iowa Agricultural Experiment Station.

In Monona County, after the issuance of the usual spring brood of flies in 1930, a secondary emergence wave occurred during the latter part of May and June. Then exceptionally dry weather and severe drought conditions prevailed during July and August, except for two short periods of rainfall on



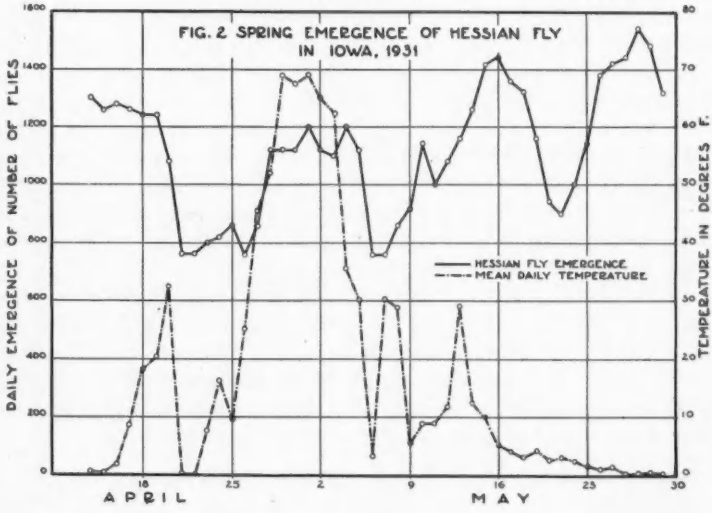


FIG. 2 SPRING EMERGENCE OF HESSIAN FLY IN IOWA, 1931
HESSIAN FLY EMERGENCE
MEAN DAILY TEMPERATURE
DAILY EMERGENCE OF NUMBER OF FLIES
TEMPERATURE IN DEGREES F.
APRIL
MAY

August 5–6 and August 17–20. Following these rains the volunteer wheat came up and, as a wave of the flies appeared, the seedlings became heavily infested with maggots. September was extremely dry with light showers on the 13th and 14th and moderately heavy rains on the 25th and 26th. Very little new volunteer wheat sprouted after these rains, but that which had started after the August rainfall continued to grow and the maggots reached the flaxseed stage during the latter. part of August and early September. Following the precipitations of August 17–20 and of September 13–14 there was a marked increase in pupation for the normal fall brood (Fig. 1). Pupation reached its peak on September 20 and then declined until on September 24 only 15 per cent of the viable flaxseeds contained pupae.

On September 23 and 24 there were no new (white) pupae which indicated that emergence was nearing the end and, consequently, the fly-free date was announced for September 27. At this time there was an indicated larval carry-over of about 34 per cent, but subsequent pupation and parasite emergence reduced this figure to 15 per cent, which figure agreed with the counts taken the following spring. Pupation and emergence for the next few days indicated that the fly-free date as predicted was safe, but following the rains of September 25–26 transformation again occurred in the old stubble and a small wave of flies emerged about October 10. This, however, was not the vital part of the Hessian fly story in Monona County.

Up until the fly-free date the late summer and early fall broods had given every indication of behaving as a normal fall brood and of spending the winter as puparia. During the last week in September, however, pupation began and a moderately large wave of emergence occurred from the 2nd to the 20th of October. Throughout this period adult flies emerged from 30.9 per cent of the flaxseeds in the volunteer wheat. On October 15–17 a microscopic examination of 1,000 flaxseeds revealed 68 dead, 31 parasitized, 592 larvae and 309 emerged. The flies from this brood, together with those of the secondary wave from the stubble, continued to emerge and deposited eggs upon almost all of the wheat above ground up to October 20, including many fields which had been planted several days after the fly-free date. The eggs deposited by this late wave hatched and the resulting larvae continued to develop during

the warm days of the mild winter of 1930. Pupariation of this late brood began in the latter part of November and continued until the middle of March. Field observations on March 9 showed that 92 per cent of the larvae had transformed to the flaxseed stage and that 8 per cent of the maggots were still active and feeding. As small and mature larvae and flaxseeds could be found in the wheat at this time, many farmers believed that they had witnessed a winter emergence and the development of a complete life cycle of the flies in midwinter.

Pupation began almost simultaneously in the flaxseeds in the old wheat stubble (15 per cent, hang-over), volunteer wheat (69.1 per cent, hang-over) and the late fall brood in the sown fields. The first fly issued on April 12 and emergence continued until the latter part of May. It is interesting to note that these different broods had reunited during the latter part of the winter and early spring and then emerged as a single and normal spring brood.

During the winter and spring months it appeared that a large percentage of the wheat would be destroyed by the fly, but an unusual combination of biotic conditions checked development of the spring brood. The severe drought, heavy dust storms, late killing frosts, and other factors destroyed many eggs and killed many newly hatched larvae before they became established on the wheat plants.

Field observations were also made in several other counties in the state. Early spring records and weather conditions showed about the same variation from normal development of the fly in Lee, Des Moines and Henry counties. In these counties immature larvae were found on the wheat plants throughout the winter months.

As a result of a more severe drought during July, August and early September in Dallas and Wapello counties, only 60 to 65 per cent of the flies issued during the fall from the old wheat stubble, the rest (35 to 40 per cent) remaining as carry-overs until the following spring. An examination of several hundred flaxseeds from old stubble at Adel, Dallas County, on March 17, 1931, disclosed that 40 per cent of them contained viable larvae. Most of these transformed and issued during the regular emergence period in the spring.

The emergence records of the spring brood of flies, as given in Fig. 2, were taken at Ames, Iowa. Heavily infested

volunteer wheat, infested plants from fields drilled after the fly-free date and old wheat stubble were collected in Monona County the first week of April and transported to the Insectary. This material, including roots and adhering soil, was then placed (according to original source of plants and stubble) upright in closely packed rows under tight concentration boxes covered with heavy roofing paper, the material from the different sources being placed in separate boxes. Two circular holes were sawed in the top of each box for the insertion of specially designed escape tubes. A large lantern globe covered with cheese-cloth was then placed over these tubes. Each day the emerging flies were removed from the globes and counted. Fly emergence began on April 14 and ended May 29. During this period 7,374 males and 8,129 females, or a total of 15,503 flies, were collected in the lantern globes.

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A REVIEW OF THE GENUS APIOCERA WESTWOOD FROM NORTH AMERICA, (APIOCERIDAE, DIPTERA).[1]

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Information concerning species of the genus *Apiocera* is scattered and less than two dozen specimens are recorded in the literature as coming to the attention of dipterists. The discovery of a third species within the United States and the possession of over 100 specimens, which include the two previously described species, has given the writer an opportunity to add to the information concerning this aberrant family. Many of the specimens were collected by the author and notes concerning the habits of each species were made and are included.

In the genus *Apiocera* there are eleven described species with a geographical distribution in the Americas, in Australia, and South Africa *Apiocera augur* O. S. and *haruspex* O. S. are found in North America; *braunsi* Melander in South Africa *obscura* (Phil.) and *philippii* Brethes (=*Anypenus brevicornis* Phil.) in Chile; *asilica* Westwood, *begotii* (Macq.), *brevicornis* (Wied), *fusicollis* Westwood, *maerens* Westwood and *vulpes* Herman in Australia. The two remaining genera in the family are North American, the species occurring in the Southwest. *Apiomidas* contains a single species, *Rhaphiomidas* four species. This makes a total of sixteen species in the family Apioceridae.

The systematic position of the genus *Apiocera* has been discussed by Osten Sacken (2), Coquillett (1), and Williston (4, 5). Since 1893 the evidence of separate family rank for this genus and *Rhaphiomidas* that Williston gives, has been generally accepted. In this last paper there are rather detailed descriptions and figures of the morphology of *A. haruspex* O. S. The other species show only minor differences in their proportions and in the structure of the male genitalia. The principal differences are in the color pattern on the abdomen, due to the presence or absence of the peculiar pollen which also covers

[1]Contribution No. 394 from the Department of Entomology.

most of the body. Under high magnification this is seen to consist of a thick mat of minute curly hair. This pollen is easily rubbed off and species of the genus have a marked tendency to become greasy. These facts may have given rise to Coquillett's (1) statement concerning the variability of *A. haruspex*. Evidence given below indicates that it may have another basis.

In the field, these specimens greatly resemble robber-flies of the genus *Erax*, with which they are frequently associated. They usually alight on the bare ground and unlike the species of *Erax*, run along the ground with a quick, darting movement, reminding one of the actions of tiger-beetles. They show a marked preference to sandy soil, but have not been observed visiting flowers, although these were more or less abundant in the locality each time. No information can be given concerning food of the adult. A female of *A. haruspex* was observed ovipositing in the ground. The enemies appear to be *Bembex* and probably the species of robber-flies with which they are associated.

KEY TO SPECIES OF APIOCERA.

1. Thorax mostly brown pollenose; in male, abdominal segments three and four largely black; California species (Figs. 5, 6).....**haruspex**
   Thorax mostly gray pollenose; black of abdominal segments not extending across dorsum.....2
2. Segments 2, 3 and 4 of abdomen with lateral triangular spots; sometimes almost lacking (Figs. 1, 2).....**augur**
   Segments 2, 3 and 4 of abdomen with lateral rectangular spots (Figs. 3, 4), **bilineata**

Apiocera bilineata n. sp.

(Figs. 3 and 4.)

A narrow, black lateral stripe on each side of abdomen, genitalia of both sexes reddish, otherwise whitish pollenose. Veins of wings partly reddish. Length, 15 to 17 mm.

Male.—Ground color of body and head black, reddish on antennae except tips, palpi, proboscis, wing base, posterior margin of scutellum, and margins of abdominal segments. Abdominal venter dark brown. Legs red, coxae, dorsal side of femora and tips of tibia largely black. Except for a stripe on each side of the abdomen and the genitalia, clothed throughout with whitish pollen or tomentum. Under magnification of 100X or more, this is seen to consist of matted, curly hairs. On the dorsum, the pollen is brownish, forming two longitudinal central stripes and an interrupted lateral stripe on the thorax, and a more or less distinct central line on the abdomen. The narrow black abdominal stripe has parallel sides, is more or less interrupted at the incisures,

and occurs on the second, third, fourth, and usually on the fifth segment. On the anterior ones it is a little more than twice as long as broad. Clothed sparsely throughout with short, whitish bristles and hairs. The short macrochaetae on the thoracic callouses, scutellum and tarsi are sometimes blackish, as are some of the hairs on the genitalia. Pulvilli less than half as long as claws, wings hyaline, veins black, reddish on the basal half; in some lights margined with irridescent blue. Genitalia red, proportionately smaller than in the other species; sternite nine often blackish, the pointed apex shorter than in the other species and bearing a tuft of hair that is less dense.

Female.—Similar to male. The velvety, black abdominal stripe is on segments two, three and four; on the fifth and following segments the pollen is very sparse, the segments shiny orange-red in color, clothed throughout with short, stiff retroarcuate hairs. The abdomen is frequently swollen with eggs and hence broader than the male. Front and face broader than in the male. Ground color contains patches of brown on thorax, especially at humeral angles.

Holotype, male, allotype female, 20 male and six female paratypes. White Sands, Otero County, New Mexico. R. H. Painter, E. M. Painter, and H. M. Smith, collectors, August 8, 1931. These were taken just inside the borders of the White Sands at the point where the Alamogordo-Organ road first approaches it. These insects were running about actively on the bare sands and were quite difficult to catch. One of the females is teneral, evidently having recently emerged. The types are in the author's collection.

This species is the smallest and lightest in color of the three North American species. The pollen is more abundant and the hairs shorter and less abundant than in the other species.

Apiocera haruspex O. S.

(Figs. 5 and 6.)

Osten Sacken's description (2) of the male is as follows:

"*Apiocera haruspex* n. sp.—Blackish-gray; abdomen black, with white cross bands; three segments preceding the black hypopygium are white. Length, 20 mm.

"Face and palpi white, beset with white pile; antennae black, basal joint beset with long white pile, front white; ocellar tubercle blackish. Thorax grayish-black above; humeral callosities white; a whitish longitudinal line and two lateral lines on the dorsum; the latter are expanded anteriorly into broad white triangles; two other white lines, curved anteriorly, between these lateral lines and the pleurae; pleurae grayish-white. Abdomen, first segment whitish on the sides, brownish in the middle, and with a fringe of black pile posteriorly; anterior margin of the second segment with a white cross-band, emargi-

nate in the middle, expanding laterally; posterior margin with two large contiguous white triangles, prolonged laterally so as to coalesce on the lateral margin with the anterior cross-band; the intermediate region of the segment is deep black, opaque; third segment black, opaque, with a white cross-band on the anterior margin, emarginate in the middle; fourth segment black, with a vestige of a narrow white margin anteriorly, concealed under the preceding segment; the three following segments white; hypopygium black, large, oblong, resembling that of an *Erax*. Venter white. Legs grayish, with black spines; tibiae and tarsi reddish-brown. Wings hyaline; veins dark brown; venation exactly like that in Mr. Philippi's figure of *Anypenus*.

"Hab.—Yosemite Valley, California. One male specimen."

Some spines on the second antennal joint are black, others white; the pile about the ocelli is brown; some of the spines behind, black. The pattern on the thorax is due to some patches bare of tomentum where the black ground color shows through and other areas where the pollen varies from brownish-black to grayish-white.

On the abdomen the anterior part of segment 1 is white pilose but the pile is black on the darker areas of all segments. The second segment is largely brownish tomentose, blending into a bare black posterior band in front of the white pollenose areas. The fourth segment has a narrow posterior white pollenose band. The fifth and following segments are dark reddish-brown to black in ground color. The fifth, sixth and most of the seventh white pollinose. The ground color of the venter is sometimes partly reddish; of the femora and coxae black, of the rest of the legs reddish, all concealed beneath grayish pollen. Most of the macrochaetae are black. The pulvillae are almost as long as the claws.

Female.—Similar to male but with a different abdominal pattern. The pollen of the center of abdomen brownish. First segment like that of male. Second gray pollinose, nearer posterior edge a black triangle with the base along lateral margin. Third and fourth with similar markings which sometimes are confluent along the apex of the segment. Fifth mostly gray or white pollenose. The remaining segments shining reddish. Fourth and following segments with retroarcuate black hairs.

Two males, the allotype female and seven paratypes collected on the road between Banning and Idyllwild, California, July 22, 1930. Elevation about 7,000 feet, T. F. Winburn and R. H. Painter, collectors. One female paratype, Herkey Creek, San Jacinto Mountains, California, July 22, 1930, T. F. Winburn and R. H. Painter, collectors. One male, Yreka,

California, July, 1926, F. M. Hull, collector, all in my own collection. In the University of Kansas collection there are seven males, one female and one pair in copula from San Jacinto Mountains, California, July 21, 1929 (R. H. Beamer), and two males, Winters, California, August 6, 1929 (L. D. Anderson). The two females, one of which is teneral, are designated paratypes.

The Yreka specimen has a little broader band of pollen at the juncture of the second and third abdominal segments; the ninth tergite has deeper apical notches, and the sternite a more accuminate apical point than in the other two specimens. This apical point is furnished with long, yellow hairs rather than the black ones found in the other species.

One of the females was observed apparently ovipositing in the loose sand of a roadway. Almost the entire abdomen was thrust into the ground and the rest of the body held nearly upright. An unsuccessful attempt was made to recover the eggs. This species was found resting on the bare earth and rocks. It showed less of a tendency to run about than did the other species.

Apiocera augur Osten Sacken.
(Figs. 1 and 2.)

Osten Sacken's description (3) of the male is as follows:

"The second of the veins issuing from the discal cell reaching the margin behind the apex; both branches of the fork of the third vein ending in the margin; the greyish-white abdomen with a pair of velvety-black, triangular spots on each of segments two, three and four. Length, including male forceps, 16–17 mm.

"Hab.—Mexico, Presidio (Forrer).

"Front and vertex silvery, beset with whitish pile, palpi yellowish-white, the last joint broad but ending in a point. Antennae blackish-brown; first joint hoary; first and second joints beset with white bristles; third joint pear-shaped, but the tip drawn out into a short, curved point. Thorax black, shining above, with some greyish-white pollen along the margins of the mesonotum; pleurae black, greyish pollinose. Abdomen greyish-white (that is, the black ground-color is entirely hidden under a covering of greyish-white pollen); segments two, three and four with, on each side, at some distance from the lateral margin, a velvety-black, more or less distinct, triangle (the apex of which is turned towards the middle and the base parallel to the lateral margin); segment five shows, in the same place, a brownish spot; the following two segments are nearly unicolorous, greyish-silvery, near the lateral margins of segments three to five elongated brown spots are perceptible; ventral surface

greyish-silvery at the base, pale reddish towards the tip; male forceps rather large, black. Halteres brownish-yellow. Legs black, or brownish-black. Wings hyaline; veins brown, the auxiliary vein, and the first vein also, more yellowish."

A few of the males have a dark brownish ground color. The mesonotum is gray pollenose with two central and two interrupted lateral stripes light brown. A similar central one on the abdomen. The short hairs on the dorsum of thorax, abdomen, and all of the genitalia are black, remaining pile longer, black. Macrochaetae black, white on antennae and on coxae. Pulvilli about three-fourths as long as claws.

Female.—Similar to male but showing a wide variation in size of the three pairs of triangular spots on the abdomen. In some specimens the latter are scarcely visible; in nearly all the bare area of the fifth and following segments encroach on the fourth segment, obliterating the spot there. Posterior part of the fourth and all of the following segments bare of pollen, brownish, shining, sparsely covered with black retroarcuate hairs. The ground color varies from a condition approaching that described for the male to one in which practically the entire body is brownish. In the latter specimens, the macrochaetae are largely white and the pollen is more uniformly gray. The lighter specimens may be partly teneral, but there is little evidence that this is the case.

Metz, Ector County, Texas, August 12, 1930, Sand Dunes, R. H. Painter, collector; one male, Orla, Reeves County, Texas, August 5, 1931, R. H. and E. M. Painter and H. M. Smith, collectors; 21 males, 43 females; also three females that had been captured by *Bembex* females and a pair taken in copula. These were taken along the banks and muddy bed of a salt water arroyo just nine miles south of the Texas-New Mexico state line on Texas Highway No. 17. They were present also along Delaware Creek just north of the state line. Both males and females were abundant about the margins of salt water pools where they appeared to be sucking up the brine from the moist sand. When disturbed, they took quick flight or ran along the ground in short, quick darts. The males were more abundant on the drier banks and the open spaces among the Creosote-bushes (*Covillea tridentata* (D. C.)). In the creek bed the *Bembex* were quite plentiful and seemed to be preying on the *Apiocerids* almost exclusively. Other mating pairs were seen. The female of the mating pair captured is designated as allotype, the other females paratypes; all in the author's collection.

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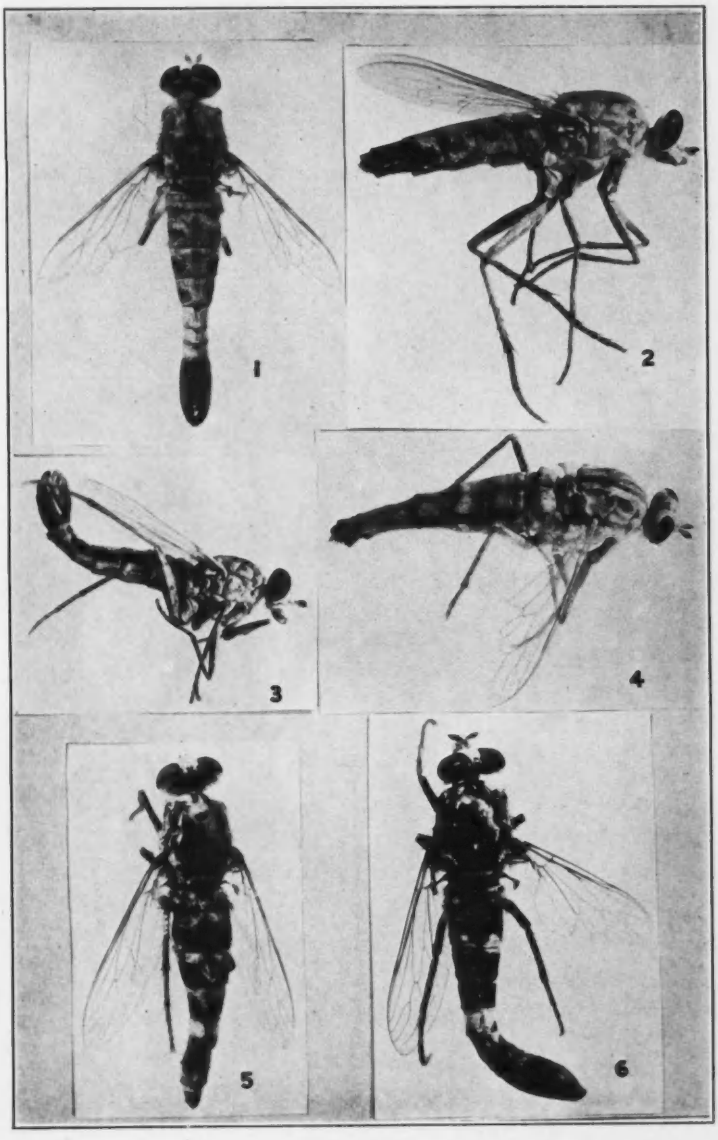
EXPLANATION OF PLATE.

Fig. 1. *Apiocera augur* Osten Sacken; male.
Fig. 2. *Apiocera augur* Osten Sacken; female.
Fig. 3. *Apiocera bilineata* n. sp.; holotype male.
Fig. 4. *Apiocera bilineata* n. sp.; allotype female.
Fig. 5. *Apiocera haruspex* Osten Sacken; female.
Fig. 6. *Apiocera haruspex* Osten Sacken; male.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THE GENUS TINOBREGMUS (HOMOPTERA, CICADELLIDAE).

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The genus *Tinobregmus* was erected by Van Duzee (1) in 1894 to accommodate the species *vittatus* which he described from female specimens from Florida. In 1898, Baker (2) stated that the species had a range extending from Virginia to Brownsville, Texas, and gave a brief description of the male which he reported as being very different in color from the female. In 1903, Osborn (3) reported *Iva frutescens* as the host plant of this species and gave a full description of the male. In 1910, Osborn (4) described the species *pallidus* from female specimens from Texas, and in 1916 DeLong (5) described *viridescens* from specimens of both sexes from Tennessee. Finally in 1917 Gibson (6) described *moodii* from Missouri, which, however, is here placed as a synonym of *viridescens*. Other references in the literature to this genus do not add to the number of species nor to their general distribution.

With a rather large series of specimens of both sexes of the genus before him the writer has made this study which adds a new species, a new variety, describes the male of *pallidus* and a dimorphic male of *vittatus*. The writer is indebted to Dr. Herbert Osborn, Dr. Dwight M. DeLong, Dr. Harry Knight and Mr. Paul Oman for the loan of specimens either from their collections or from those of the institutions they represent.

This genus appears to the writer to be a striking illustration of a group with several species in the making. The species discussed in this paper appear to be clearly differentiated but they do not yet have some of the definite or clear-cut characteristics so common among most genera of leafhoppers. For example, while slight variations in them occur, neither the external nor internal genitalia of either sex show definite enough differences to be of any use in the separation of the species. The plates, pygofers and claspers all show slight differences between the species, but just as definite variations also occur within the species. These structures, therefore, cannot be used

[1]Contribution from the Department of Entomology, University of Kansas.

in this genus for the separation of species. However, the variations within the species, as for example in color and in the shape of the vertex, indicate a state of change now taking place. Thus the females of *vittatus* vary from specimens with the pronotum and elytra practically unmarked to specimens very strikingly marked, and *pallidus* varies all the way from unmarked to heavily colored individuals. Variations in the shape of the vertex are clearly seen in specimens of *vittatus* even from the same locality and even wider differences are seen in specimens from different localities as is shown in Figures 5 and 8.

But in spite of such variations, the species here listed are easily separated by the very evident differences in the shape of the head. The color markings also afford definite specific characters in both sexes, and the size of the several species furnishes a further delimiting character.

DESCRIPTION OF GENUS.

Head always distinctly narrower than pronotum. Vertex narrow at caudomesal angle of eyes, expanded anteriorly, and with an unusually broad strip extending caudad of eyes, anterior margin varyingly produced but broadly rounded with front; face unusually long due to very elongate front and unusually long clypeus which is widened distally and has a concave apical margin. Pronotum short, over twice as wide as long, broadened posteriorly, always longest at middle. Scutellum very small. Elytra broad, rounded apically, varying in length from half as long as abdomen to many specimens with elytra reaching pygofer and occasional male specimens with elytra as long as abdomen. Venation varying from very obscure to very distinct; usually with four apical cells, the outer one, formed by the branching of the outer branch of the first sector, being the largest. Wings very small. Legs, especially the metathoracic pair, very long. Last ventral segment of female long, produced on median third. Ovipositor distinctly exceeding pygofer. Pygofer of male greatly narrowed posteriorly and hooked apically; plates slender, apical half finger-like, shorter than pygofer; claspers about length of pygofer, basal half stout, suddenly narrowed at middle which bears a short dorsal process, apical half curved dorsad and gradually expanded to apex; oedagus about length of claspers, slender, curved dorsad at slender apex.

KEY TO SPECIES.

1. Vertex very acute; both sexes strikingly yellow and black..... **viridescens**
   Vertex less acute; females not distinctly yellow and black..... 2
2. Vertex obtuse, not over one-fourth of it projecting cephalad of eyes.. **vittatus**
   Vertex more acute, one-third of it projecting cephalad of eyes..... 3
3. Larger species, over 6 mm.; vertex more obtuse..... **invenustus**
   Smaller species, under 6 mm.; vertex more acute..... **pallidus**

Tinobregmus vittatus Van Duzee.
(Figs. 1, 5, 8 and 9.)

Tinobregmus vittatus Van Duzee, Bul. Buf. Soc. Nat. Sci., v, p. 214, 1894.

The most robust species of the genus, with vertex relatively more obtuse. Length of female, 5 to 6.5 mm.; male 4 to 4.5 mm.

Females with not over one-fourth of vertex projecting cephalad of eyes, anterior margin usually rounded but often appearing slightly angulate. Elytra reaching tip of seventh or on to eighth abdominal segment; veins always distinct but varying very greatly in width and prominence.

Color.—Females, straw yellow marked with brown or black. Vertex usually with two black spots at apex and another pair around ocelli; frequently with additional black spots between or caudad of these. Pronotum often with just the suggestion of brown stripes; lateral stripes are first to become distinct and black, then outer discal pair, and last of all the middle pair; usually the six stripes are distinct with middle pair brown and the others black. Elytra often unmarked, simply with brownish tinge. In process of coloring four brown or black apical spots first appear, then cells begin to darken and veins become wider and more prominent. In fully colored specimens veins become very wide and white and cells distinctly dark brown. Face with faint suggestions of two longitudinal brown stripes near margins of front or varyingly darker till stripes are distinct and dark and continued as a broad stripe down middle of clypeus. Underside straw yellow, varyingly marked with fuscous.

Males of two distinct colorations. One type (Fig. 1) with vertex black except for small light spots between eyes and light along posterior border of occiput. Pronotum yellowish white except for black lateral margins. Elytra reaching pygofer, yellowish white except for black band across apex which is usually very narrow, rarely one-fourth the length of elytra. Face entirely black or with lorae and genae light. Underside brown to black. Legs brown to black, usually with tips of femora lighter.

The above form, described by Baker (2) and Osborn (3) is the commoner type and has been the only form of male known up to the present time. The writer now has before him a series of males, taken with males of the type described above and with a large series of females, which are distinctly different and which have the coloration of the females. These males are described as follows:

Males.—Resembling females in color. (Fig. 9.) Vertex straw yellow with ocelli and two small apical spots black. Pronotum straw yellow with lateral stripes always present and discal stripes often present, the median ones brown, the others black. Elytra straw yellow with four black spots at apex which are sometimes fused. Rest of elytra unmarked or with a number of distinct brown stripes in cells as in

female. Face light except for two brown stripes on front and single median one on clypeus. Underside straw yellow, varyingly marked with brown.

Morphotype, Cameron County, Texas, August 3, 1928, R. H. Beamer. *Paramorphotypes*, ten in number, from Cameron, Bee, Jim Wells and Brooks counties, Texas.

Types deposited in Snow Entomological Collection.

Distribution.—This species has been recorded from Virginia, North Carolina, Florida, Louisiana and Texas. Specimens from Mississippi are now at hand.

A considerable variation in the shape of the vertex in this species is seen by a comparison of Figures 5 and 8. The former is typical of specimens taken in Texas and shows the usual shape of the vertex for the species; the latter figures a specimen loaned by Dr. Osborn, from Bermuda. The Bermuda specimen also shows suggestions of two additional stripes on the pronotum, a condition seen in just a few other specimens. The specimens here figured seem to be distinct enough to be different species, but all gradations between them are found and no dividing line can be drawn.

Tinobregmus pallidus Osborn.

(Figs. 6 and 7.)

Tinobregmus pallidus Osborn, Ohio Nat., xi, p. 261, 1910.

Smaller, with head narrower and vertex more produced than in *vittatus*. Length of female, 4.5 to 5.5 mm.

Vertex with about one-third its length extending cephalad of eyes, anterior margin distinctly more acute than in *vittatus*. Elytra extending on to eighth abdominal segment.

Color.—Straw yellow with suggestions of frontal stripes and with or without black border at apex of elytra. Underside with few dark markings, ovipositor black.

The writer has before him a series of specimens from Texas, agreeing in shape of vertex and in all other respects with the pale specimen described above, which, in turn, was compared with a cotype kindly loaned by Dr. Osborn. These specimens, however, have various color markings on the pronotum, elytra and front. In some cases these markings are very faint, but a clear series is at hand showing the progressive development of the color pattern from utterly unmarked specimens to an extreme where the pronotum has six definite stripes and the elytra are dark brown except for the pale costal border and veins and a light line along sutural margins.

The writer is convinced, therefore, that *T. pallidus* was described from specimens which had not yet colored up, and that most of the specimens belonging to the species will show more or less definite coloring.

A series of males, some taken along with females of *pallidus* and others in nearby counties are at hand. These differ definitely from the males of *vittatus* and are clearly the males of *pallidus*. They are described as follows:

More wedge-shaped than *vittatus*, head narrower and more produced; elytra extending on to pygofer. Length, 3.5 to 4.5 mm.

Color.—Head black. Pronotum yellowish-white except for narrow black lateral margins. Elytra yellowish-white, their apices black, with black band extending forward for one-fourth or more the length of elytra, and distinctly further than in *vittatus*. Underside black, cheeks sometimes lighter, apices of femora and rest of legs sometimes lighter.

A specimen from Harris County, Texas, taken by R. H. Beamer, July 28, 1928, is designated as *Allotype* and deposited in the Snow Entomological Collection. Additional males are at hand from many localities in Texas.

Distribution.—Known only from Texas.

Tinobregmus pallidus var. **elegans** var. n.

(Fig. 10.)

Form and structure of typical *pallidus*, but strikingly marked as follows: Pronotum with six definite brown stripes. Elytra with narrow yellow stripe along sutural margins, rest of clavus with broad brown stripe, tapering to a point posteriorly, a broad yellow stripe laterad of this, a definite brown stripe on corium splitting into three or four parts on apex, a broad yellow stripe along costal margin. Frons with distinct brown longitudinal stripes which meet and form central stripe on clypeus.

Holotype, female, Kendall County, Texas, July 22, 1928, A. M. James. Type deposited in Snow Entomological Collection.

Tinobregmus invenustus sp. n.

(Fig. 2.)

Allied to *pallidus* but larger and with vertex more obtuse. Length of female, 6.5 mm.

Head quite narrow, with fully one-third of vertex extending cephalad of eyes; anterior margin more obtuse than in *pallidus*. Elytra extending on to eighth abdominal segment. Legs exceedingly long.

Color.—Vertex dirty yellow with ocelli darker and with brownish areas along anterior margin. Pronotum straw yellow, with no signs

of discal stripes; lateral stripes jet black. Elytra straw yellow, with only a faint suggestion of a few apical brown spots. Tip of abdomen straw yellow, variously marked with brown; ovipositor black. Front rich chestnut brown except for pale median line; clypeus brown with two black stripes, lorae and cheeks yellow. Underside mostly black. Legs pale but heavily marked with fuscous especially on pro- and mesothoracic femora and the apices of metathoracic femora.

Holotype, female, Natchitoches Parish, La., August 16, 1928, R. H. Beamer. *Paratype*, same data.

Types deposited in Snow Entomological Collection.

Tinobregmus viridescens DeLong.

(Figs. 3 and 4.)

Tinobregmus viridescens DeLong, Tenn. St. Bd. Ent., Bul. 17, p. 92, 1916.
Tinobregmus moodii Gibson, Can. Ent., xlix, p. 183, 1917.

Distinctly greenish-yellow, with tips of elytra black banded in both sexes. Head narrower and vertex more acute than in other species. Length of female, 5.5 to 6 mm.; male, 4.5 mm.

Head very narrow; fully one-third of vertex extending cephalad of eyes, anterior margin quite acute. Elytra extending on to eighth abdominal segment in female; nearly to end of pygofer in male.

Color.—Female vertex yellow, unmarked except for brownish ocelli. Pronotum yellow, usually with anterior margin bordered with black, with black lateral stripes, rarely with dark discal stripes. Elytra greenish-yellow, with black apical band about one-sixth length of elytra and sometimes a few brownish lines on clavus or disc of corium. Face pale except for two brown stripes on front and for brown clypeus. Underside mostly dark.

Male with vertex nearly entirely black. Front and clypeus usually entirely black. Elytra without signs of stripes and with apical black band occupying over one-fourth their length.

Distribution.—Described from Tennessee. The writer has seen specimens from Mississippi, Maryland, Illinois and Missouri in addition.

An examination of the types of *T. moodii* Gibson shows them to be typical specimens of *T. viridescens* DeLong.

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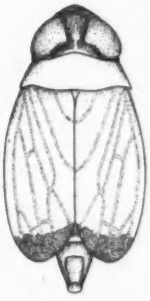

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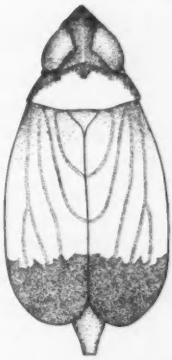
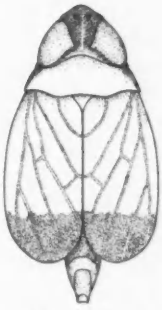
2. T. invenustus ♀

3. T. viridescens ♀



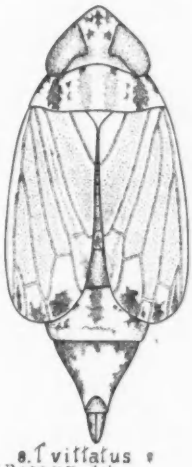
4. T. viridescens ♂

5. T. vittatus ♀



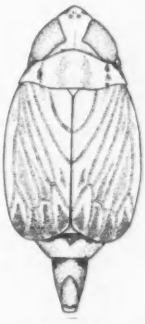
6. T. pallidus ♂

7. T. pallidus ♀

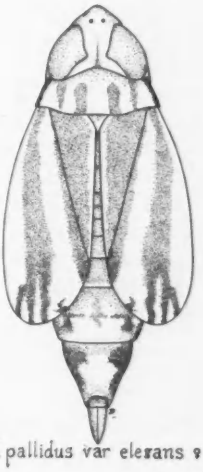


8. T. vittatus ♀

K. Doering del.



9. T. vittatus ♂



10. T. pallidus var elerans ♀

OBSERVATIONS ON THE FLIGHT OF NOCTUID MOTHS.

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A review of the literature on the nocturnal habits of noctuids shows that little is known as to the height that these insects may fly. Felt (1, 2, 3) has discussed very thoroughly the dissemination of insects by air currents and cites instances of migrations of southern noctuids to northern and northeastern states. He made collections from high buildings in Albany, New York, and this information is now in the press. Coad (4) has made a study of insects occurring at high altitudes, with the aid of airplanes, and found insects as high as 14,000 feet. He states in part that "the strong-flying insects, such as the cotton leaf-worm moth and similar species, are found as high as 3000 feet or lower, although occasional individuals are found as high as 5000 feet."

During the past season several collections of noctuids were made at lights on the two highest buildings in Knoxville, Tennessee. Five collections were made on the Hotel Andrew Johnson, which is located on the main throughfare of the city and a block from the Tennessee River. This building is eighteen stories (220 ft.) high above the street level, and is equipped with a searchlight used in connection with the local airport. A 1000-watt lamp with a large reflector projects a beam of light in a westerly direction. One collection was made from the seventeen-story General Building, which is three blocks from the Hotel Andrew Johnson and nearer the center of the business district. A 75-watt lamp was used for a light attractant on this building. The insects were caught in small vials or with an insect net as they crawled or flew around the light.

The beam of light projected from the top of the hotel was so bright that it was possible to see insects sixty yards or more. A gentle breeze was blowing from the southwest and the flying insects were always drifting with the wind and rising when they crossed the light beam. In most cases only the moths that came as close to the light as 15 feet were attracted

by it. Beyond that distance, they would often make a circle or zigzag as if stimulated by the light, but would continue their flight, which seemed to be with the wind and always upwards.

Bats were plentiful; they were seen at all times catching insects and often chasing moths that were flying toward the

TABLE I.

LIST OF NOCTUIDS CAUGHT ON HIGH BUILDINGS IN KNOXVILLE, TENNESSEE, DURING 1931.

NAME	DATES CAPTURED	TOTAL NUMBER
Heliothis obsoleta Fabr	Sept. 9, 17, Nov. 11	6
Feltia gladiaria Morr	Oct. 3, 5	7
Feltia ducens Wlk	Sept. 17, Oct. 3, 5	9
Feltia subgothica Haw	Sept. 9, 17	6
Lycophotia margaritosa Haw	Nov. 11	1
Lycophotia infecta Ochs	Sept. 9, 11, Oct. 5	4
Rhynchagrotis alternata Grt	Oct. 3	1
Rhynchagrotis anchocaliodes Gn	Sept. 9	1
Rhynchagrotis cupida Grt	Sept. 11	1
Polia renigera Steph	Sept. 17, Oct. 3, 5	10
Polia laudabilis Gn	Sept. 17	1
Eriopyga lindseyi Benj	Sept. 9	2
Eriopyga crenulata Butl	Sept. 9	1
Cirphis phragmatidicola Gn	Sept. 11	1
Parastichtis ferrugineoides Gn	Nov. 11	7
Perigea apameoides Gn	Oct. 3	1
Perigea sutor Gn	Sept. 11, 17, Oct. 3	4
Acronicta pruni Harv	Sept. 17	1
Prodenia ornithogalli Gn	Sept. 9, 11, 17, Oct. 5	7
Caradrina tarda Gn	Sept. 9, 11, 17	62
Monodes grata Hbn	Sept. 9, 11, 17, Oct. 3	6
Lithacodia musta G. & R	Sept. 17	1
Lithacodia carneola Gn	Sept. 9	1
Ogdoconta cinereola Gn	Sept. 11, 17	2
Tarache aprica Hbn	Sept. 11	1
Caenurgia erechtea Cram	Sept. 9, 11	2
Caenurgia crassiuscula Haw	Sept. 17	1
Autographa simplex Gn	Sept. 9	1
Autographa ou Gn	Sept. 17	2
Unidentified, 3 species	Sept. 9, 11, Oct. 3	3

light source. While in only two instances were they actually seen to catch moths, they sometimes interfered with the collector in his attempts to make a catch.

Collections were made during the early part of the evening on five different dates. The moths caught, with dates and the total number captured, are listed in Table I. The list includes 32 species, three of which are unidentified.

The largest catch was on September 9, when 60 specimens were secured, representing 13 species. The number of species could probably be increased by continuing collections over a longer period.

Other insects that were abundant on top of the buildings would represent about all the orders. The most conspicuous were leafhoppers, beetles, ant lions, aphis lions, may flies, stinkbugs, lygaeids, and winged ants.

A study of the habits of nocturnal insects will yield much valuable information, and the many light beacons used in connection with air transportation afford entomologists throughout the country an excellent laboratory for studying our night-flying insects.

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1. **Felt, E. P.** The dissemination of insects by air currents. Jour. Econ. Ent. 18: p. 152–156. 1925.
2. **Felt, E. P.** Dispersal of insects by air currents. N. Y. State Mus. Bul, 274, p. 59–129. 1928.
3. **Felt, E. P.** Insect inhabitants of the upper air. Fourth International Congress of Ent. 2: 869–872. 1928.
4. **Coad, B. R.** Insects captured by airplane are found at surprising heights. U. S. Dept. of Agr. Yearbook, p. 320–323. 1931.

BOOK NOTICE

THE INSECT MENACE, by L. O. Howard, pp. I–XV and 1–347, 35 plates and many text figures. The Century Co., New York and London.

This volume is a very interesting non-technical and popular account of the relations of man to his insect enemies. From Doctor Howard's pen it is authoritative. The material is covered in nine chapters as follows: I, How long have insects existed on the earth? II and III, Why the insect type has persisted (Powers of concealment, of multiplication. The number of species. The skeleton, other anatomical advantages. Diet and its adaptations, physiology, senses. Are insects automata or do they think?) IV, Other important facts (Life underground, aquatic insects, adaptation to winds). V, The problem confronting us (How man is helping insects increase and spread. The losses.). VI, Injuries aside from damage to crops (Insects as carriers of disease of man and of plants. As mere nuisances. Not all insects injurious.). VII and VIII, The world is waking up (What we are doing to combat the menace. Insect control by other insects. Variation in crop practice. Mechanical and chemical control. Quarantines.). IX, Three instances of progress (Rocky Mountain locust, cotton boll weevil and Mediterranean fruit fly. (Conclusion).

Because Doctor Howard is a world figure and has had for many years as head of the U. S. Bureau of Entomology, more world contacts than any other living entomologist, he has been able to use these in constant reference, thus giving the volume an intense human interest. In the descriptions of the travels of Koebele, Tothill and Muir the volume reaches its climax and becomes intensely interesting. But it is interesting from cover to cover. Doctor Howard has that ability as a writer. It is a volume which should be read by every entomologist as the broadest and best general statement of the problems and conquests of economic entomology.

—C. H. K.

THE APHIDAE OF COLORADO.

PART II.

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Fort Collins, Colorado.

Part I of this paper was published in Annals of the Entomological Society of America Vol. 24, p. 827 to 934, Dec., 1931. It includes tribes Lachnini and Callipterini of the subfamily Aphinae. Part II includes subtribe Aphina of the tribe Aphina. Part III will contain the remaining tribes and subfamilies of the Aphidae.

Tribe **Aphini.**

Characters.—Frontal tubercles more or less developed. Secondary sensoria circular or oval. Antennae longer than half of body, unguis filamentous. Hairs inconspicuous. Wax secretion rare. Cornicles usually elongated, rarely mere pores or absent, very rarely truncate. Cauda conical to elongated. Rostrum 4-jointed, terminal joint indistinct. Fore wings with radial sector curved and distinct.

KEY TO SUBTRIBES OF APHINI.

A. Body naked except for a few hairs.
  B. Head without prominent frontal tubercles. (Page 369).....**Aphina**
BB. Head with prominent frontal tubercles.
  C. Fore wings with radial sector simple. (To appear in Part III).**Macrosiphina**
  CC. Fore wings with radial sector united with fork of media. (Not recorded from Colorado.) (To appear in Part III).....**Pentalonina**
AA. Body covered with long projections. (Not recorded from Colorado.) (To appear in Part III).....**Cervaphina**

Subtribe **Aphina.**

Characters.—Frontal tubercles but slightly developed, on inner side only; hardly ever exceeding vertex.* Hairs usually pointed, short, on antennae hardly ever longer than diameter of joint. Lateral and ocular tubercles present. Secondary sensoria circular. Rostrum 4-jointed, tip or terminal joint indistinct. First tarsal joint approximately triangular.

*Ocellus not counted as part of vertex in comparisons with frontal tubercles.

KEY TO GENERA OF APHINA.

A. Tarsi lacking. (Page 458)..... **Atarsos**
AA. Tarsi present.
B. Antennae 5-jointed. (Page 469)..... **Cerosipha**
BB. Antennae 6-jointed.
C. Dorsal tubercle present on terminal segment of abdomen.
D. Cornicles with opening on inner side of tip. (Page 456).. **Aspidaphis**
DD. Cornicles with opening not on inner side of tip. (Page 465), **Cavariella**
CC. Dorsal tubercle lacking on terminal abdominal segment.
D. Frontal tubercles entirely lacking; vertex flat.
E. Cornicles with knob-like enlargement at tip. (Page 470), **Epameibaphis**
EE. Cornicles not knob-like at tip but slightly swollen on inner side near tip. (Page 477)..... **Pseudoepameibaphis**
DD. Frontal tubercles slightly developed; vertex convex.
E. Cornicles absent. (Page 455)..... **Asiphonaphis**
EE. Cornicles present.
F. Cornicles not longer than width at base.
G. Body of apterae hemispherical. (Page 492)..... **Siphonatrophia**
GG. Body of apterae not hemispherical.
H. Body hairs conspicuously flabellate. (Page 472), **Flabellomicrosiphum**
HH. Body hairs not flabellate.
I. Cauda shorter than broad. (Page 475)..... **Microsiphum**
II. Cauda longer than broad. (Page 460)..... **Brachycolus**
FF. Cornicles longer than width at base.
G. Cauda rounded, not longer than broad.
H. Frontal tubercles exceeding vertex. (Page 370), **Amphicercidus**
HH. Frontal tubercles not exceeding vertex. (Page 461)... **Braggia**
GG. Cauda conical to spoon-shaped, longer than width at base.
H. Cornicles cylindrical.
I. Media twice-forked. (Page 373)..... **Aphis**
II. Media once-forked. (Page 494)..... **Toxoptera**
HH. Cornicles incrassate or clavate.
I. Cornicles longer than cauda. (Page 478).... **Rhopalosiphum**
II. Cornicles not longer than cauda.
J. Cauda elongate, distinctly longer than wide at base. (Page 473)..... **Hyalopterus**
JJ. Cauda conical, not distinctly longer than wide at base. (Page 463)..... **Brevicoryne**

Genus **Amphicercidus** Oestlund.

Oestlund, 19th. Rept. St. Ent. Minn., p. 126, 1922.

Characters.—Vertex convex. Frontal tubercles produced on inner side, slightly exceeding vertex. Hairs pointed or blunt. Cauda short and broad, resembling anal plate, bearing short hairs no longer than those on vertex. Cornicles cylindrical, transversely wrinkled. Antennae with numerous sensoria, at least on joint III of alate viviparae. Mediae of fore wings twice forked. Rostrum obtuse, terminal joint indistinct. Tarsi slender; hind tarsi one-seventh to one-sixth the length of tibiae.

Taxonomy.—This genus is very close to *Anuraphis* and may be considered by some as congeneric. Takahashi (Pr. Ent. Soc. Wash., Vol. 32, p. 8) considers *Amphicercidus* as a

synonym of *Neoacaudus* Theobald. Theobald, however, described his genus as "devoid of any prominent frontal tubercles." Not having access at present to even the original description of the genotype of *Neoacaudus* it seems best to hold to the American genus which was erected for the Colorado species.

Genotype, *Aphis pulverulens* Gillette. (See below.)

KEY TO SPECIES OF AMPHICERCIDUS.

A. Sensoria present on antennal joint IV in alate viviparae. Cornicles much longer than hind tarsi. (Page 372).....**flocculosa**
AA. Sensoria absent on antennal joint IV in alate viviparae. Cornicles not longer than hind tarsi. (Page 371).....**pulverulens**

Genotype **Amphicercidus pulverulens** (Gillette).

Gillette, Jo. Ec. Ent., Vol. 4, p. 324, 1911. *Aphis.*

Color.—Viviparae. Sordid greenish-brown; covered with abundant pulverulence; cauda, cornicles, legs and antennae concolorous with

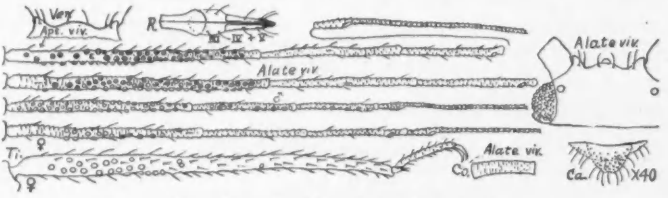

FIG. 101. *Amphicercidus pulverulens.*

body to dusky; stigmae pale brownish. Young—Pale carneous, often greenish.

Measurements.—Alate vivipara.—Body 3 mm.; hind tibiae 1.6 to 1.7 mm.; hind tarsi .26 mm. and slender; antennae 2.4 to 2.9 mm.; III .80 to .90 mm.; IV .42 to .57 mm.; V .30 to .43 mm.; VI .13 + .50 to .60 mm.; cornicles .20 to .23 mm.; cauda .09 mm. entire length, .05 mm. hard portion; rostrum obtuse, joint IV + V .15 mm., barely attaining 2d. coxae. Apterous summer vivipara.—Same as alate vivipara.

Structural Characters.—Vertex slightly convex. Frontal tubercles produced on inner side slightly exceeding vertex. Secondary sensoria round, small, convex, with narrow margins, scattered over almost entire length of joint, about 40 in number on III; absent in all other joints in both alate and apterous viviparae. Hairs pointed or slightly knobbed, drooping, .02 to .03 mm. long on antennae and body; .04 and .05 mm. long on outside of tibiae. Cornicles cylindrical, weak, without distinct flange, faintly imbricated or transversely wrinkled. Cauda broadly conical, rounded or semilunar, very faintly setulose, bearing 5 hairs on each side and 2 median ones near tip; hairs hardly curved and hardly longer than those on vertex. Ocular tubercles shallow and broad,

inconspicuous. Fore wings with 2d. fork of media .33 to .5 the distance from margin of wing to first fork. Lateral tubercles not apparent. Body integument covered with glandular reticulations. Males apterous.

Collections.—On bark of *Symphoricarpos* sp. at or below surface of ground; at Fort Collins, Boulder and Ward; apterous summer viviparae May 2 to Aug. 9, alate viviparae May 10 to Aug. 9, sexuales Oct. 15 and 18, oviparae Nov. 25; 15 collections, rather common.

Types in collection of U. S. Nat. Mus., Cat. No. 41926; paratypes in collection of Colo. Agr. Exp. Sta.

Amphicercidus flocculosa (Gillette and Palmer).

Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 22, p. 7, 1929. *Anuraphis.*

Color.—Viviparae.—Blackish-brown, on thorax and abdomen, dull orange or clay color on head, lateral margins and bases of cornicles;

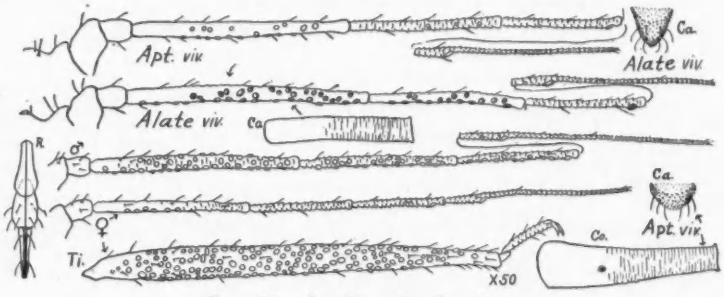

FIG. 102. *Amphicercidus flocculosa.*

cornicles, antennae and legs yellowish-brown to dusky; entire dorsum in both alate and apterae covered with powdery secretion.

Measurements.—Apterous summer vivipara.—Body 2.75 mm.; hind tibiae 1.20 to 1.50 mm.; hind tarsi .20 to .22 mm. and slender; antennae 1.90 to 2.40 mm.; III .50 to .68 mm.; IV .32 to .48 mm.; V .30 to .37 mm.; VI .11 to .15 + .35 to .54 mm.; cornicles .50 to .68 mm.; cauda entire length .10 mm.; about twice as broad as long, on median line of hard portion .06 to .08 mm.; rostrum attaining 3d. coxae. Alate vivipara.—Body 2.30 mm. long; hind tibiae 1.30 mm.; hind tarsi .20 mm.; antennae 2.2 mm.; III .58 to .77 mm.; IV .37 to .48 mm.; V .32 to .37 mm.; VI .12 + .48 to .65 mm.; cornicles .39 to .46 mm.; cauda .11 mm. entire length, about as broad as long, .06 to .07 mm. on median line of hard portion; rostrum rather acute, joint IV + V .15 mm. long, attaining 2d. coxae.

Structural Characters.—Secondary sensoria small, round, convex, with narrow margins, and scattered along nearly entire length of joint, on alate viviparae about 40 on III, and 8 to 16 on IV; on apterae, 10 to 20

on III, and 0 to 3 on distal half of IV; oviparae with 3 to 8 on III. Cornicles as broad as femora, cylindrical to tapering, marked with very fine and faint transverse wrinkles which are often difficult to see, so that cornicles appear smooth, with narrow but distinct flange. Cauda rounded, semilunar, bearing 3 hairs on each side. Lateral tubercles present and distinct but weak; on prothorax and all abdominal segments. Hairs pointed, .03 to .05 mm. long on vertex and antennae; on cauda hardly longer than on vertex. Ocular tubercles shallow and broad, inconspicuous. Dorsal integument marked with delicate reticulations. Oviparae with hind tibiae but slightly swollen and thickly covered along entire length with medium-sized sensoria. Males alate.

Collections.—On leaves and twigs of *Lonicera* sp. at Fort Collins; apterous summer viviparae June 6 to July 20, alate viviparae June 10 to Oct. 28, oviparae Oct. 13 to Nov. 24, male Oct. 28; 15 collections, not rare.

Types in collection of the U. S. Nat. Mus., Cat. No. 41456; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species is very peculiar on account of the unusually long cornicles, very short cauda, the heavy pulverulence and numerous sensoria on antennae of apterae. It appears to be closely allied to *Aphis lonicericola* Williams, but differs in the presence of sensoria on antennal III of apterous viviparae, the much longer cornicles and antennal joints, III equalling 4 times base of VI, and the rounded cauda. *A. flocculosa* differs from *Amphicercidus pulverulens* (Gillette) in the much larger cornicles, presence of sensoria on antennal joint IV and the presence of small lateral tubercles. The marked resemblances in frontal tubercles, pulverulence, antennal and caudal characters and slender tarsi seem to indicate generic relationship.

Genus **Aphis** Linnaeus.

Linnaeus, Syst. Nat., 10th. Ed., p. 451, 1758.

Characters.—Vertex slightly convex. Antennal tubercles never exceeding vertex; slightly produced on inner margin only. Antennae of 6 segments. Secondary sensoria subcircular usually with narrow rims. Cornicles cylindrical or slightly tapering. Cauda subconical to cylindrical, often constricted near the base, very setulose. Hairs pointed; on body, antennae and legs, rarely longer than diameter of joints; on cauda nearly as long as cauda and curved. Anal plate rounded. Wing venation normal; mediae twice branched. Rostrum 4-jointed with terminal or 5th. joint indistinct. Males often alate, oviparae apterous. Living on leaves, twigs and roots of deciduous trees and plants.

Taxonomy.—The genus *Aphis* is here used to include *Anuraphis* Del. G. The genus *Anuraphis* is not considered by the writers to be distinct since the most nearly distinguishing character seems to be the conical shape of the cauda. This seems to correlate with no other character and is itself unsatisfactory on account of numerous intergrading forms and the close similarity to the cauda of *Aphis sambuci* L., the genotype of the genus *Aphis*. *Anuraphis* might be used as subgenus by any who are so inclined but no attempt is made here to separate the group.

Genotype, *Aphis sambuci* Linnaeus (See below.)

KEY TO SPECIES OF APHIS.

A. Rostrum acute, tip conspicuously slender ventrally, resembling distinct 5th. joint.
B. Cornicles reticulated distally. (Page 381)..... **artemisicola**
BB. Cornicles not reticulated.
C. Cauda acutely conical. Rostrum not attaining abdomen. On *Chrysothamnus*. (Page 391)..... **chrysothamnicola**
CC. Cauda bluntly conical. Rostrum attaining abdomen. On *Artemisia*.
D. Cornicles distinctly shorter than base of antennal VI. Entire dorsum covered with white reticulation. (Page 420).. **minutissima**
DD. Cornicles not distinctly shorter than base of antennal VI. Dorsum with broken pattern of white reticulation.
E. Cornicles subequal with base of VI. Antennal III not longer than .14 mm. (Page 397)..... **filifoliae**
EE. Cornicles longer than base of VI. Antennal III longer than 14 mm.
F. Unguis shorter than 1.5 times base of VI. Cornicles 1.5 to 2 times base of VI. (Page 385)..... **canae**
FF. Unguis 1.5 to 2 times base of VI.
G. Cornicles 2 to 3 times base of VI. Antennal III .19 to .25 mm. long. (Page 406)..... **hermistonii**
GG. Cornicles longer than 3 times base of VI. (Page 426), **oregonensis**
AA. Rostrum obtuse, tip not conspicuously slender.
B. Cornicles smooth, not imbricated.
C. Rostrum with joint IV + V broad, less than 3 times as long as width base. Cauda acute. (Page 446)..... **solidaginifoliae**
CC. Rostrum with joint IV + V slender, 3 times as long as width at base. Cauda obtuse.
D. Anal plate with median projection. Sensoria less than 10 on antennal III of alatae. (Page 436)..... **rociadae**
DD. Anal plate without median projection. Sensoria 10 or more on antennal III of alatae.
E. Cauda broad, not longer than base of VI, without blunt hairs. (Page 404)..... **helichrysi**
EE. Cauda slender, longer than base of VI, bearing 1 or 2 blunt hairs at apex. (Page 382)..... **asterensis**
BB. Cornicles imbricated.
C. Hind tibiae of all viviparae bearing sensoria.
D. Sensoria located on proximal half of hind tibiae. Cornicles shorter than twice base of antennal VI. (Page 443)..... **sensoriata**
DD. Sensoria located on distal half of hind tibiae. Cornicles longer than twice base of antennal VI. (Page 452)..... **viburnicola**

CC. Hind tibiae of viviparae not bearing sensoria.
D. Rostrum broadly obtuse (joint IV + V shorter than twice width at base).
E. Cornicles slightly incrassate; imbrications setulose. Cauda spoon-shaped. (Page 415)..... **maidis**
EE. Cornicles cylindrical, imbrications not evidently setulose.
F. Unguis 3 to 4 times length of cauda.
G. Unguis 5 to 6 times base of VI. Cubitus of hind wing vestigial. (Page 444)..... **setariae**
GG. Unguis 3 to 4 times base of VI. Cubitus of hind wing distinct. (Page 389)..... **cerasifoliae**
GGG. Unguis 2 times base of VI. Cubitus of hind wing distinct. **sambuci**
FF. Unguis shorter than 2 times cauda, and 2 to 2.5 times base of VI. (Page 392)..... **circezandis**
DD. Rostrum slenderly obtuse (Joint IV + V longer than twice width at base).
E. Cauda* not longer than broad.
F. Cauda bearing at least 6 hairs on each side.
G. Sensoria circular to oval with wide rims. Unguis distinctly longer than III. (Page 407)..... **incognita**
GG. Sensoria circular with narrow rims. Unguis not longer than III.
H. Cornicles shorter than antennal V.
I. Antennal III 1.5 to 2 times unguis. Sensoria at least 20 on III in alatae. (Page 394)..... **debilicornis**
II. Antennal III subequal with unguis. Sensoria less than 10 on III in alatae. (Page 442)..... **senecio-radicis**
HH. Cornicles not shorter than antennal V.
I. III less than 3 times base of VI. Sensoria on III of alatae less than 20.
J. Sensoria on III in alatae less than 10, in apterae usually less than 8.
K. III in apterae .17 to .22 mm., bearing 0 to 3 sensoria. Hind tibiae of oviparae distinctly swollen throughout and covered with sensoria. (Page 414).... **maidi-radicis**
KK. III in apterae .23 to .30 mm., bearing 2 to 7 sensoria. Hind tibiae of oviparae swollen only on proximal .33 bearing about 3 sensoria. (Page 417)... **menthae-radicis**
JJ. Sensoria on III in alatae 10 or more, in apterae about 8 or more. (Page 418)..... **middletonii**
II. III 3–4 times base of VI. Sensoria on III of alatae 20 or more. (Page 454)..... **viburniphila**
FF. Cauda bearing fewer than 6 hairs on each side.
G. Cornicles shorter than 1.5 times base of VI.
H. Imbrications on cornicles plainly setulose. (Page 383)... **bakeri**
HH. Imbrications on cornicles not evidently setulose.
I. Cauda bearing 2 hairs on each side of base. (Page 396).. **eriogoni**
II. Cauda bearing at least 4 hairs on each side.
J. Antennae of alatae with more than 20 sensoria on III. (Page 422)..... **neilliae**
JJ. Antennae of alatae with not more than 10 sensoria on III.
K. Rostrum surpassing 2d. coxae. Color green. Hind tibiae of oviparous female bearing more than 10 sensoria. (Page 401)..... **gregalis**
KK. Rostrum not surpassing 2d coxae. Color pink or brown. Hind tibiae bearing not more than 10 sensoria. (Page 427)..... **ornata**
GG. Cornicles at least 1.5 times as long as base of VI.
H. Hairs slightly capitate. Cornicles slightly curved. Frontal tubercles produced slightly beyond vertex. (Page 437)... **rosea**

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*Cauda length and width in key refers to length on median line of sclerotic or hard portion and width at base of this portion.

HH. Hairs pointed. Cornicles straight. Frontal tubercles not attaining vertex.
I. Cornicles not longer than 1.5 times hind tarsi. (Page 450)...**tulipae**
II. Cornicles longer than 1.5 times hind tarsi.
J. Cauda shorter than half of base of VI. Color black. (Alatae with sensoria on IV). (Page 430).....**persicae-niger**
JJ. Cauda at least half as long as base of VI.
K. Cornicles shorter than unguis. Color green with dusky markings. (Page 387).....**cardui**
KK. Cornicles longer than unguis. Color brown and black. (Page 389).....**ceanothi-hirsuti**
EE. Cauda longer than broad.
F. Cauda tapering, ending in a point.
G. Cauda bearing 6 or more pairs of hairs. Cauda longer than base of antennal VI.
H. Cornicles shorter than 3 times base of VI, subequal with unguis. (Page 410).....**lupini**
HH. Cornicles 3 to 4 times base of VI, longer than unguis.
I. Unguis shorter than 3 times base of VI. Color green or pink. (Page 440).....**saliceti**
II. Unguis at least 3 times base of VI. Color brown to black. (Page 412).....**maculatae**
GG. Cauda bearing fewer than 6 pairs of hairs. Cauda not longer than base of antennal VI.
H. Unguis subequal with III.
I. Cornicles shorter than 2 times hind tarsi. Antenna .5 to .66 length of body. Sensoria on III in alatae fewer than 10. (Page 408).....**laciniariae**
II. Cornicles as long as 2 times hind tarsi. Antennae nearly as long as body. Sensoria in alatae more than 10. (Page 388)...**ceanothi**
HH. Unguis shorter than III.
I. Sensoria present on antennae of apterae and IV and V of alatae. (Page 428).....**pentstemonicola**
II. Sensoria absent on antennae of apterae and IV and V of alatae.
J. Cornicles once to 1.5 times base of VI. Color green. (Page 384).....**bonnevillensis**
JJ. Cornicles shorter than base of VI. Color grayish or green. (Page 449).....**tetrapteralis**
JJJ. Cornicles longer than 2 times base of VI. Color brown. (Page 389).....**ceanothi-hirsuti**
FF. Cauda not tapering, tip rounded.
G. Cauda about as long as 2 times base of VI. (Page 411).....**lutescens**
GG. Cauda never longer than 1.5 times base of VI.
H. Cauda not bushy, fewer than 5 hairs on each side.
I. Rostrum not surpassing 2d. coxae.
J. Body 1.1 to 1.5 mm. Cornicles black. On *Monarda*. (Page 421).....**monardae**
JJ. Body 1.5 to 1.8 mm. Cornicles pale. On *Ribes*. (Page 435).....**ribiensis**
II. Rostrum surpassing 2d. coxae.
J. Unguis longer than III.
K. Rostrum with joint IV + V longer than base of antennal VI. Alate viviparae with fewer than 6 sensoria on antennal III. (Page 397).....**forbesi**
KK. Rostrum with joint IV + V subequal with base of antennal VI. Alate viviparae with more than 6 sensoria on antennal III.
L. Cauda with slight neck. (Page 398).....**frangulae**
LL. Cauda without slight neck. (Page 393).....**cornifoliae**
JJ. Unguis not longer than III.
K. Cauda knob-like or wart-shape distal to neck. (Page 391).....**cercocarpi**
KK. Cauda approximately cylindrical distal to neck or base.

L. Antennal IV longer than V. Rostrum with joint IV + V .15 mm. long and more than 3 times as long as width at base. (Page 430)..... **phaceliae**
LL. Antennal IV not evidently longer than V. Rostrum with joint IV + V .12 mm. long, not longer than 3 times width at base.
M. Rostrum surpassing hind coxae. (Page 425)..... **oestlundi**
MM. Rostrum not surpassing hind coxae.
N. Antennal IV of alatae typically with sensoria. (Page 379) **abbreviata**
NN. Antennal IV of alatae typically without sensoria.
O. Sensoria on III of alatae 7 to 10. Color green. (Page 400)..... **gossypii**
OO. Sensoria on III of alatae not more than 7. Color black. (Page 416)..... **medicaginis**
HH. Cauda bushy, 5 or more hairs on each side.
I. Unguis subequal with III.
J. Cauda but slightly longer than wide, rather wart-shaped distal to neck. (Page 441)..... **sambucifoliae**
JJ. Cauda distinctly longer than wide, cylindrical or spoon-shaped distal to neck.
K. Sensoria not more than 10 on III of alatae.
L. Hind tibiae of oviparae distinctly swollen, covered with numerous sensoria. (Page 447)..... **spiraecola**
LL. Hind tibiae of oviparae not swollen, bearing few sensoria. (Page 433)..... **pomi**
KK. Sensoria more than 10 on III of alatae.
L. Sensoria typically absent on V in alatae.
M. Color brownish-green to black. Rostrum not hairy. (Page 439)..... **rumicis**
MM. Color light green. Rostrum hairy. (Page 423)..... **neomexicana**
LL. Sensoria typically present on V in alatae.
M. Cornicles usually shorter than unguis. On *Oenothera*.
N. Color green. (Page 424)..... **oenotherae**
NN. Color pale rusty-yellow. (Page 424)..... **oenotherae** var. **rufa**
MM. Cornicles usually longer than unguis. On *Ribes*. (Page 452) **varians**
II. Unguis usually distinctly shorter than III.
J. Unguis not longer than 1 to 1.5 times base of VI. (Page 448) **spiraephila**
JJ. Unguis 1.5 to 2 times base of VI.
K. Rostrum not surpassing 2d. coxae. Color black. (Page 386) **carbocolor**
KK. Rostrum surpassing 2d. coxae. Color green.
L. Cornicles slightly narrowed in middle. Unguis at least 1.5 timesV. Sensoria on III of alatae less than 10, none on IV. (Page 438)..... **rubicola**
LL. Cornicles not narrowed in middle. Unguis shorter than 1.5 times V. Sensoria on III of alatae atleast 20, present on IV.
M. Sensoria on III in alatae usually over 25, more than 12 on IV and more than 5 on V. (Page 422)..... **neilliae**
MM. Sensoria on III in alatae usually fewer than 25, on IV fewer than 12, on V fewer than 4.
N. Unguis longer than IV. Rostrum attaining abdomen. Body 1.6 to 2 mm. (Page 399)..... **fraserae**
NN. Unguis shorter than IV. Rostrum not attaining abdomen. Body 2 to 2.9 mm. (Page 409)..... **lugentis**
JJJ. Unguis 2 to 3 times base of VI.
K. Cauda about half as long as base of VI, hardly longer than broad. Color brown. (Page 454)..... **viburniphila**
KK. Cauda .66 to as long as base of VI, nearly twice as long as broad. Color green.
L. Cornicles 1.5 to 2 times base of VI. Sensoria typically present on IV in alatae and often in apterae. (Page 451)..... **valerianae**
LL. Cornicles 2 to 3 times base of VI. Sensoria typically absent on IV in alatae and never present in apterae.
M. Unguis usually longer than 1.3 times IV. (Page 402)... **helianthi**
MM. Unguis usually shorter than 1.3 times IV. (Page 405) **heraclella**

[Genotype **Aphis sambuci** Linnaeus.]

Linnaeus, Syst. Nat., Ed. 10, p. 451, 1758.
For fuller description see Theobald, Aph. Gr. Brit., Vol. 2, p. 95 to 98, 1929.

Color.—Viviparae.—Sooty-black to blackish-green; dull in apterae, shining in alatae;* (white tessellations evident on apterae in half tone by Theobald); appendages black. Young—Bright green to dark green.

Measurements.—Apterous vivipara.—Body globose, 3.3 to 3.8 mm.; hind tibiae 1.50 mm.; hind tarsi .16 mm.; antennae 1.90 mm.; III .50 mm.; IV .32 mm.; V .32 mm.; VI .20 + .35 mm.; cornicles .65 to .73 mm.; cauda .23 mm. entire length, .12 mm. hard portion; rostrum. obtuse, joint IV + V broad .17 mm. by .10 mm. attaining between 2d. and 3d. coxae. Alate vivipara.—Body 2 to 2.8 mm.

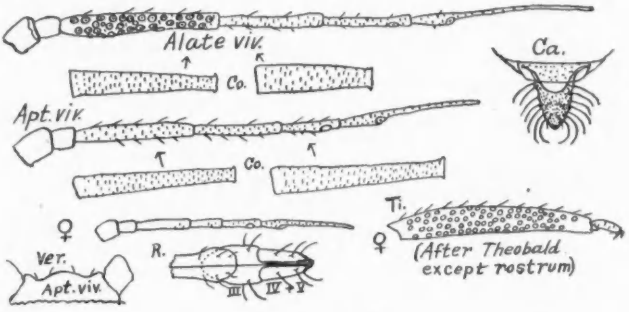


FIG. 103. *Aphis sambuci.*

Structural characters.—Vertex slightly convex. Frontal tubercles but slightly developed on inner side, not exceeding vertex. Secondary sensoria round, with narrow margins, scattered over entire length of joint, 30 to 36 on III, none on IV or V in alate viviparae; absent in apterae. Hairs pointed, .03 to .04 mm. long, at angle of 45 degrees or more, fairly numerous on body and antennae; .05 to .07 mm., numerous and nearly erect on tibiae; .12 mm. long, heavier and curved on cauda. Cornicles cylindrical to tapering, slender distally narrower than hind tibiae, with slight flange, closely marked with curved imbrications. Cauda parallel-sided, broad, with obtusely conical tip and slight tendency to constriction before base, or subconical, bearing 3 or 4 lateral, and 3 dorsolateral hairs on each side and about 4 on dorsum. Lateral tubercles present on pronotum and abdominal segments 1, 2, 3, 4, 5 and 7.

Hosts.—Leaves and twigs of *Sambucus nigra.* [Description from data from Theobald. (loc. cit.) and amplified from study of apterous viviparae determined and sent by D. Hille Ris Lambers, Wageningen, Holland.] Not recorded from the state.

*Alatae, unless otherwise stated, have head and thorax dark brown to black in all species in this paper.

Aphis abbreviata Patch.

Patch, Me. Agr. Exp. Sta. Bul. 202, p. 170, 1912.

Color.—All forms.—Pale green to yellowish; darker green on median line, lateral and posterior portions of abdomen, and dusky on lateral areas in alatae, cauda and cornicles dusky; legs and antennae pale or but slightly dusky in apterae, darker in alatae.

Measurements.—Alate vivipara.—Body 1.30 to 1.50 mm.; hind tibiae .75 to .90 mm.; hind tarsi .10 mm.; antennae 1.15 to 1.20 mm.; III .26 to .32 mm.; IV .17 to .22 mm.; V .16 to .18 mm.; VI .10 to .12 + .26 to .31 mm.; cornicles .19 to .23 mm.; cauda .17 mm. entire length, .10 mm. hard portion. Rostrum obtuse, attaining between 2d. and 3d. coxae, joint IV + V moderately slender, .11 mm. long. Apterous summer vivipara.—Same as alata except body 1.50 to 1.80 mm.; and cornicles .23 to .31 mm.

Structural Characters.—Secondary sensoria round, rather large, with diameter from .5 to .66 diameter of antennal joint, arranged in single or

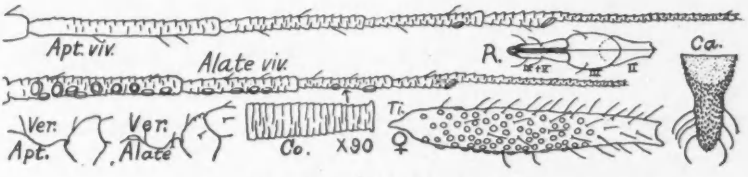


FIG. 104. *Aphis abbreviata.*

partly double row along entire length of joint III, 8 to 11 in number; on IV 2 to 4 in single row, on V 0 to 1 in alate viviparae; absent in apterous viviparae. Hairs .01 to .02 mm. long, drooping and sparse on vertex and antennae; on cauda .05 mm. long and curved. Cornicles cylindrical or slightly tapering, with flange and imbricated or transversely wrinkled. Cauda cylindrical, blunt, with slight neck and broader base, bearing 3 or 4 hairs on each side. Mediae of fore wings with 2d. fork .33 to .5 the distance from margin of wing to 1st. fork. Males not taken. Oviparae with hind tibiae conspicuously swollen on proximal .75 and covered with small slightly convex sensoria.

Collections.—On leaves and stems of *Rhamnus cathartica*, curling leaves at Fort Collins; fundatrices April 16, apterous summer viviparae April 30 to July 21, alate viviparae April 28 to Nov. 4, oviparae Nov. 2 to 4; 10 collections, rather common.

Taxonomy.—This species is believed by Patch (Me. Agr. Exp. Sta., Bul. 317, p. 43, 1924) to be *Aphis solanina* Passerini as published by Theobald (The Aphides attacking the Potato, Southeastern Agr. Coll. Wye, 1922). Theobald (Aphid Gr. Br. Pt. 2, p. 202) feels sure that *abbreviata* Patch is the same as the aphid described by him as *Aphis rhamni* Boyer. Boyer's *rhamni*, however, is listed as *Myzus* by Schouteden (Mem.

Soc. Ent. Belg. T. 12, p. 233, 1906) also by Soliman (Univ. of Cal. Pub. Ent., Vol. 4, p. 134, 1927), and this throws uncertainty on the determination of Boyer's species. Furthermore Theobald's description of *rhamni* Boyer reads so much like his description of *solanina* Pass. that he might have had the same species, especially considering the variety of hosts found for this aphid by Patch. In order to avoid confusion it has appeared best to follow the example of Patch (Me. Agr. Exp. Sta., Bul. 317, p. 43, 1924) and designate the species as *Aphis abbreviata* Patch for the present.

Aphis argentinae-radicis Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 25, p. 140, 1932.

Color.—Apterous summer vivipara.—Pale greenish with mottling of darker green; head, terminal abdominal segments and speckles over dorsum dusky; cornicles, anal plate, cauda and entire legs blackish. Young individuals paler, dusky only on head and tips of antennal joints and legs.

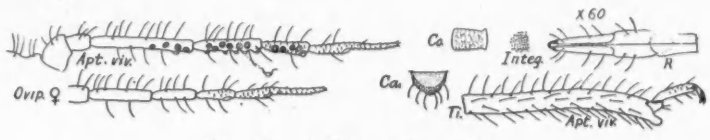


FIG. 105. *Aphis argentinae-radicis.*

Measurements.—Apterous summer vivipara.—Body 1.4 to 1.7 mm.; hind tibiae .90 mm.; hind tarsi .12 mm.; antennae .75 to 1.05 mm.; III .23 to .34 mm.; IV .13 to .21 mm.; V .12 to .15 mm.; VI .10 + .13 to .17 mm.; cornicles .08 mm.; cauda .04 mm. hard portion, .08 mm. entire length; rostrum obtuse, joint IV + V slender, .16 mm. long, .05 mm. wide at base, attaining abdomen.

Structural Characters.—Secondary sensoria circular with rather broad rims, strongly convex and set on tubercles, 2 to 14 scattered along distal .75 or .5 of III, 1 to 15 along entire length of IV, 1 to 7 on V in apterae. Hairs fine, pointed, erect, numerous, .04 to .05 mm. long, on vertex, antennae and outer side of hind tibiae. Dorsal surface finely setulose but not showing reticulate pattern. Cornicles tapering, one and one-half times as wide at base as at tip, diameter at middle about the same as hind tibiae, imbrications finely setulose, flanges rather large. Cauda rounded, not longer than broad, bearing 2 pairs of lateral and one pair of apical hairs. Lateral tubercles present. Oviparae with hind tibiae bearing about 2 sensoria near middle, not noticeably swollen.

Collections.—On roots of *Argentina anserina;* at Pingree Park, Colorado, apterous summer viviparae and one apterous ovipara Aug. 23; one collection, rare.

Types in U. S. Nat. Mus., Cat. No. 43844; paratypes in collection of Colo. Agr. Exp. Sta.

Aphis artemisicola Williams.

Williams, "Aphididae of Nebraska," Univ. Studies, Vol. 10, p. 37, April, 1910.

For fuller description see Gillette and Palmer, Ann. Ent. Soc. Am., Vol. 21, p. 14, 1928.

Color.—Viviparae.—Reddish-vinaceous-black, shining; antennae and legs brownish to blackish; cornicles black; cauda brown.

Measurements.—Apterous summer vivipara.—Body 2 mm., robust; antennae 1.75 mm.; joint III .38 to .47 mm.; IV .27 to .35 mm.; V .25 to .30 mm.; VI .12 to .14 mm. + .50 to .65 mm.; cornicles .25 to .33 mm.; cauda .10 mm. on median line; hind tibiae 1 to 1.1 mm.; hind tarsi .15 mm. Rostrum attaining 2d. or 3d. pair of coxae, acute, joint IV + V tapering, .16 mm. long, tip beyond hairs, compressed laterally, .0175 mm. wide at base, .01 mm. distally, .06 mm. long, resembling a distinct 5th. joint. Alate vivipara.—Body 2 mm.; antennae 2 to

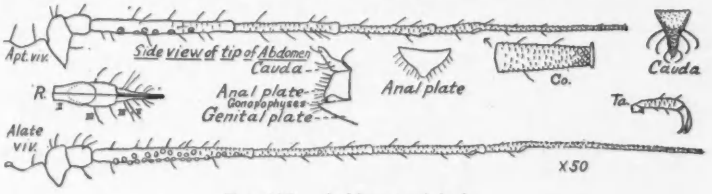


FIG. 106. *Aphis artemisicola.*

2.50 mm.; joint III .42 to .55 mm.; IV .32 to .39 mm.; V .30 to .38 mm.; VI .13 + .53 to .80 mm.; cornicles .30 to .35 mm.; other parts as in apterae.

Structural Characters.—Vertex convex. Frontal tubercles very slight; first antennal joint slightly gibbous. Secondary sensoria round and flat, in apterous viviparae 1 to 8 in a single row on joint III; in alate viviparae tuberculate, 18 to 29 scattered along entire length of joint III, 1 or 2 on IV. Hairs spine-like, on antennae equal to or longer than diameter of antenna. Cornicles cylindrical, with flange, with 1 to 3 fine hairs usually evident, imbricated to distal .2 which is reticulated. Cauda acute, distal portion slender, conical, sometimes almost parallel-sided, bearing 2 or 3 pairs of curved hairs and sometimes one median, heavy, blunt, spine-like hair evident. Anal plate with median wart-like protuberance, projecting ventrally, not posteriorly. Mediae of fore wings with 2d. fork about .5 from margin to 1st. fork. Sexuales unknown.

Collections.—On leaves and stems of *Artemisia cana, longifolia,* and *tridentata* near Meeker, Rio Blanco, Sargent, Steamboat Springs and Kremmling; apterous summer viviparae July 11 to Aug. 8, alate viviparae July 11; 6 collections, very abundant on infested plants.

Taxonomy.—The Colorado examples differ from the type specimens in fewer sensoria and shorter measurements; but this does not at present seem sufficient to warrant the erection of either a new species or variety.

Aphis asterensis Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. of Am., Vol. 22, p. 22, 1929.

Color.—Viviparae.—Pale greenish-yellow somewhat mottled; legs and cornicles pale with dusky tips; wing veins heavy and black.

Measurements.—Apterous vivipara.—Body to base of cauda 1.3 mm.; hind tibiae .60 mm.; hind tarsi .09 mm.; antennae .75 mm.; III .17 to .26 mm.; IV .10 mm.; V .08 mm.; VI .09 + .14 to .20 mm.; cornicles .11 to .15 mm.; cauda .12 mm. hard portion, entire length .14 mm.; rostrum obtuse, joint IV + V .10 mm. long, attaining between 2d. and 3d coxae. Alate vivipara.—Body to base of cauda 1.4 mm.; hind tibiae

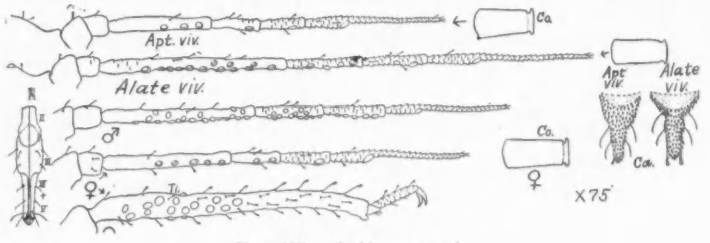


FIG. 107. *Aphis asterensis.*

.70 mm.; hind tarsi .10 mm.; antennae 1.1 mm.; III .33 to .40 mm.; IV .15 mm.; V .12 mm.; VI .11 + .23 mm.; cornicles .10 to .15 mm.; cauda .14 mm. entire length, .09 mm. hard portion.

Structural Characters.—Secondary sensoria round, rather large, irregular in size, arranged in a row along almost entire joint, 10 to 14 on III, 4 to 6 on IV, and 0 to 1 on V in alate viviparae; in apterous viviparae 2 to 3 on III, 0 to 1 on IV. Cornicles cylindrical, without imbrications, with flange and with constriction just before flange. Cauda elongate, irregularly parallel-sided in distal .5 or .66, narrower than cornicles, abruptly spreading at base to twice diameter of distal part, bearing a pair of capitate hairs near tip and two pairs of slightly curved ones near base. Hairs on body and appendages capitate, very short and sparse on antennae. Mediae of fore wings with 2d. fork about .5 to .66 the distance from margin of wing to 1st. fork. Sensoria on hind tibiae of oviparae large, round, flat, located on proximal half, 8 to 16 in number. Males alate.

Collections.—On leaves and stems of *Aster multiflorus* near Fort Collins; apterous summer viviparae May 8 to Oct. 5, alate viviparae May 8 to May 29, sexuales Oct. 5; 5 collections, rather rare.

Types in U. S. Nat. Mus., Cat. No. 41464; paratypes in collection of Colo. Agr. Exp. Sta.

Aphis bakeri Cowen.

Gillette and Baker, "Hemip. Colo." Agr. Exp. Sta., Bul. 31, p. 118, 1895.

Color.—Viviparae.—Dull yellowish-green to pinkish; alatae with dusky lateral areas and dorsal bands, which coalesce on segments anterior to cornicles; apterae without dusky markings except on tip of abdomen, head, and bases of hairs, the latter being often quite conspicuous, especially in the immature examples; cornicles slightly dusky.

Measurements.—Apterous vivipara.—Body to base of cauda 1.7 to 2.2 mm.; hind tibiae .80 mm.; hind tarsi .10 mm.; antennae .90 to 1.1 mm.; joint III .15 to .36 mm.; IV .11 to .18 mm.; V .10 to .15 mm.; VI .09 to .12 + .18 to .28 mm.; cornicles .11 to .14 mm.; cauda .08 mm. hard portion, .14 mm. entire length; rostrum obtuse, joint IV + V .09 to .11 mm. long, slightly surpassing 2d. coxae. Alate vivipara.—Body

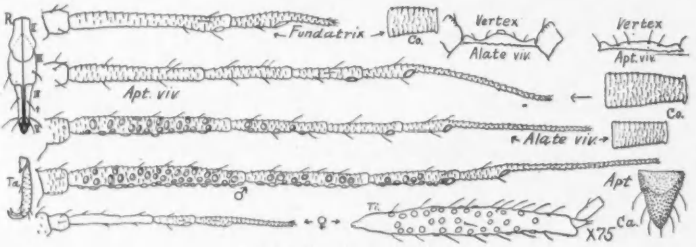


FIG. 108. *Aphis bakeri.*

to base of cauda 1.75 to 2 mm.; hind tibiae .90 mm.; hind tarsi .10 mm.; antennae 1.12 to 1.4 mm.; III .31 to .40 mm.; IV .19 mm.; V .16 mm.; VI .10 + .30 to .35 mm.; cornicles .10 to .12 mm.; cauda .05 to .10 mm. hard portion, entire length .14 mm.; rostrum obtuse, joint IV + V .10 to .12 mm. long, hardly attaining 2d. coxae.

Structural Characters.—Secondary sensoria circular, tuberculate, 25 to 30 on III, and 6 to 10 on IV, scattered along entire length of joints; absent in apterae. Hairs pointed, sparse, and drooping, shorter than diameter of antennal joints, .01 to .02 mm. on vertex, antennae and tibiae. Cornicles cylindrical or slightly tapering, with setulose imbrications and distinct flange. Cauda conical, subequal to cornicles in length, bearing 3 to 4 hairs on each side. Lateral tubercles present. Mediae of fore wings with 2d. fork about .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae swollen and bearing about 30 rather large sensoria scattered along entire length. Males alate.

Collections.—On leaves and tips of twigs of *Pyrus malus*, *P. communis* and *Crataegus* sp. as winter host, and on *Trifolium* sp., *Melilotus* sp., and *Capsella bursa-pastoris* as summer host;

generally throughout the state; fundatrices on winter hosts March 19 to June 11, apterous summer viviparae on summer hosts March 22 to Dec. 23; alate summer viviparae on winter hosts April 24 to June 8, and Oct. 1 to Nov. 9, and stragglers throughout the summer on summer hosts March 22 to Dec. 13; sexuales on the winter hosts Oct. 3 to Nov. 9; 160 collections, very common.

Taxonomy.—This species and *Aphis senecio* Swain appear to differ only in the shorter rostrum and setulose imbrications on cornicles of *bakeri*. Cornicles are smooth in specimens of *A. senecio* received from California.

Aphis bonnevillensis Knowlton.

Knowlton, G. F., Ann. Ent. Soc. Amer., Vol. 21, p. 262, 1928.

Color.—Viviparae.—Blue-green; antennae, legs and cornicles pale.

Measurements.—Alate vivipara.—Body 1.33 mm. long, antennae .80 mm.; III .20 to .25 mm.; IV .15 to .18 mm.; V .13 to .16 mm.; VI

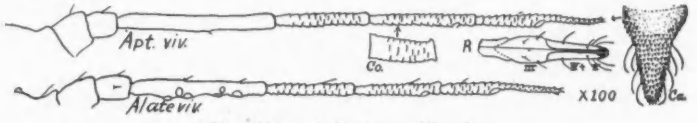


FIG. 109. *Aphis bonnevillensis.*

.10 to .12 + .10 mm.; hind tibiae .90 mm.; hind tarsi .11 to .13 mm.; cornicles .10 to .14 mm. Apterous viviparae.*—Body 1.45 mm.; antennae .85 mm.; III .27 to .30 mm.; IV .15 to .20 mm.; V .18 mm.; VI .11 to .15 mm. + .10 mm., hind tibiae .83 mm.; hind tarsi .11 to .14 mm.; cornicles .17 mm.; cauda .10 mm. on median line of hard portion, .14 mm. entire length; rostrum obtuse, joint IV + V slender, .10 mm. long, attaining 3d. coxae.

Structural Characters.—Secondary sensoria circular, arranged in a row along most of joint III, 4 to 8 in number in alate viviparae; absent in apterae. Hairs on vertex and antennae fine, sparse, pointed, .01 mm. long; on middle of outside of hind tibiae .015 to .02 mm., sparse; on cornicle .03 to .05 mm. long and curved. Cornicles cylindrical or slightly swollen near distal end and constricted before flange, imbricated. Cauda long-conical with tendency to constriction near base, bearing 4 hairs on each side. Lateral tubercles evident only on prothorax. Mediae of fore wings with 2d. fork .33 to .5 the distance from margin of wing to 1st. fork.

*About 12 apterae were taken in a single collection which appear to differ in size only. Body 1.3 mm.; hind tibiae .50 mm.; hind tarsi .10 mm.; antennae .53 to .60 mm.; III .12 to .15 mm.; IV .08 to .09 mm.; V .09 to .10 mm.; VI .08 to .10 + .08 to .10 mm.; cornicles .07 mm.; cauda .10 mm.; hard portion bearing 2 or 3 hairs on each side; rostrum with joint IV + V .09 mm. long, attaining 3d. coxae.

Collection.—On leaves and twigs of *Sarcobatus vermiculatus* at Manzanola and Grand Junction; apterous and alate viviparae May 18, dwarf apterae at Grand Junction June 24; two collections, probably not rare but little collecting has been done in localities where the host occurs.

Aphis canae Williams.

Williams, "Aph. Neb." Univ. Studies, Vol. 10, p. 39, 1910.

For fuller description see Davis. Univ. Studies, Lincoln, Nebr., Vol. 11, No. 3, p. 11, 1911.

For taxonomic discussion see Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 21, p. 10, 1928. *Anuraphis.*

Color.—Viviparae.—Green with darker mottling; apterae with whitish band on 1st. abdominal segment and lighter color around margins of body, head darker; cornicles black; legs pale.

Measurements.—Apterous vivipara.—Body to base of cauda 1.60 mm., hind tibiae .55 mm. Antennae .71 to .93 mm.; III .16 to .22 mm.; IV .13 to .18 mm.; V .11 to .15 mm.; VI .08 to .10 + .08 to .13 mm.; cornicles .15 to .25 mm.; cauda .04 mm. hard portion, .09 mm. entire length; hind tibiae .45 to .60 mm.; hind tarsi .10 mm. Rostrum acute,

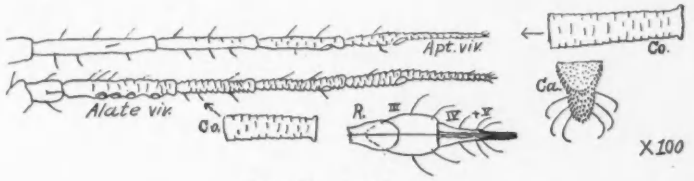


FIG. 110. *Aphis canae.*

joint IV + V tapering, .14 mm. long, tip beyond hairs compressed laterally, .01 to .015 mm. wide, .06 mm. long, resembling distinct 5th. joint; attaining 1st. abdominal segment. Alate vivipara.—Body 1.24 mm. Antennae .82 to .92 mm.; III .18 to .20 mm.; IV .12 to .16 mm.; V .14 to .15 mm.; VI .10 + .13 to .16 mm., cornicles .11 to .15 mm.

Structural Characters.—Secondary sensoria circular, large, in single row, 3 to 5 on III of alate viviparae; absent in apterae. Cornicles cylindrical, with flange, and imbricated. Cauda more or less elongate-conical, bearing 3 curved hairs on each side. Lateral tubercles developed on prothorax and 1st. and 7th. abdominal segments. Mediae of fore wings with 2d. fork .33 to .5 the distance from margin of wing to 1st. fork.

Collections.—On leaves and stems of *Artemisia cana, filifolia, tridentata* and *longifolia* near Steamboat Springs, Denver, Kremmling and North Park; apterous summer viviparae June 17 to Aug. 8, alate viviparae June 17 to July 15; 6 collections, not abundant.

Taxonomy.—This group containing, *A. canae, filifoliae, hermistonii* and *oregonensis*, presents a very puzzling series of gradations. No structural differences, other than size and proportions of antennal joints and cornicles, were detected; and no distinct line can be drawn between any of the forms. Neither is any definite aid to be gotten from the host species as we have taken each variety on several of *Artemisia*. On the other hand the limits of variation represented by the extreme forms make it seem rather improbable that only one species is concerned. This is supported by the fact that with but a few exceptions, the individuals of a single collection always fall in the same group. Since the several species have been established it seems to the authors most advisable to hold them distinct until further study proves otherwise.

Aphis carbocolor Gillette.

Gillette, Can. Ent., Vol. 39, p. 391, 1907.

Color.—Viviparae.—Deep, dull, sooty-black throughout; legs and antennae mostly yellowish.

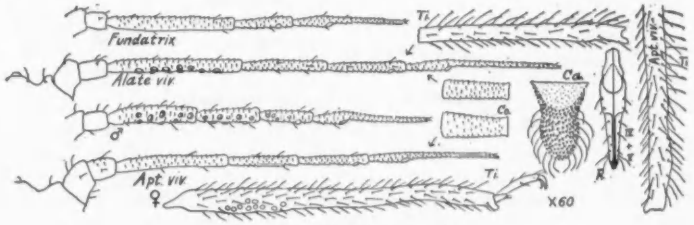


FIG. 111. *Aphis carbocolor.*

Measurements.—Apterous summer vivipara.—Body to base of cauda 2.1 to 2.5 mm.; hind tibiae 1 mm.; antennae 1.1 to 1.3 mm.; III .26 to .40 mm.; IV .18 to .24 mm.; V .17 to .22 mm.; VI .11 + .23 to .24 mm.; cornicles .21 to .26 mm.; cauda .12 mm. on hard portion on median line, .15 mm. entire length. Alate vivipara.—Body to base of cauda 1.9 mm.; hind tibia 1 mm.; hind tarsi .13 mm.; antennae 1.3 mm.; III .34 to .40 mm.; IV .21 to .26 mm.; V .20 to .23 mm.; VI .11 to .14 + .25 to .28 mm.; cornicles .17 to .26 mm.; cauda .08 mm. hard portion; rostrum obtuse, joint IV + V .14 mm. long, attaining 2d. coxae.

Structural Characters.—Secondary sensoria round and flat, arranged in single or partly double row along almost entire length of III, 8 to 12 in number, none on IV in alate viviparae; absent in apterae. Hairs pointed, fine, drooping, very sparse, .02 to .03 mm., on vertex and antennae; on tibiae .06 to .07 mm., semi-erect and numerous. Cornicles

cylindrical, finely imbricated, and without flange. Lateral tubercles well developed on prothorax and all abdominal segments. Mediae of fore wings with 2d. fork about .33 the distance from margin of wing to 1st. fork. Cauda broadly cylindrical, with slight neck, blunt, bearing about 7 pairs of lateral hairs. Oviparae with hind tibiae slightly swollen and bearing rather large sensoria. Males apterous.

Collections.—On leaves and stems of *Rumex* sp. at Fort Collins, Boulder, Paonia, Palisade, Manzanola, Canon City, Denver, Rocky Ford and Mears Junction; fundatrices April 1 and May 27, apterous summer viviparae April 9 to Nov. 4, alate viviparae May 2 to Sept. 5, sexuales Sept. 30 to Oct. 18; 60 collections, very common.

Types in U. S. Nat. Mus., Cat. No. 41925; paratypes in Colo. Agr. Exp. Sta.

Aphis cardui Linn.

Linnaeus, Syst. Nat., Ed. 10, p. 452, 1758.

Color.—Viviparae.—Green or yellowish with large dorsal patch and bands in both apterae and alatae, sometimes black throughout; legs yellowish; cornicles black.

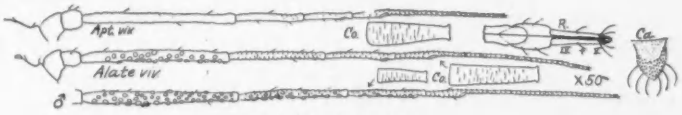


FIG. 112. *Aphis cardui.*

Measurements.—Apterous vivipara.—Body to base of cauda 2 to 2.3 mm.; hind tibiae 1 mm.; antennae 1.40 mm.; III .32 to .38 mm.; IV .22 mm.; V .15 mm.; VI .09 + .32 to .36 mm.; cornicles .22 to .25 mm. Alate vivipara.—Body to base of cauda 2 mm.; hind tibiae 1.20 mm.; hind tarsi .13 mm.; antennae 1.9 mm.; III .45 mm.; IV .30 mm.; V .21 mm.; VI .13 + .46 mm.; cornicles .28 to .32 mm.; cauda .07 mm. hard portion on median line; rostrum obtuse, joint IV + V slender, .19 mm. long, attaining 3d. coxae.

Structural Characters.—Secondary sensoria round, flat, scattered along entire length of joint III, 30 in number in alate viviparae; absent in apterae. Cornicles cylindrical, very faintly imbricated, nearly smooth, with slight flange. Cauda conical, broader than long, held erect, bearing 3 hairs on each side. Hairs pointed, very sparse and short; on antennae hardly as long as .5 diameter of joints. Lateral tubercles present on prothorax and abdominal segments. Mediae of fore wings with 2d. fork .5 or more of distance from margin of wing to 1st. fork. Males alate.

Collections.—On leaves and stems of *Carduus* and *Prunus* (?) at Bellvue, Fort Collins, Grand Mesa, Virginia Dale, and

Battle Creek; apterous summer viviparae June 17, alate viviparae Aug. 15, alate male Oct. 27, on Italian prune at Twin Falls, Idaho, taken by Ralph H. Smith; 5 collections in state, rare, especially on eastern slope of Rocky Mountains.

Aphis ceanothi Clarke.

Clarke, Can. Ent., Vol. 35, p. 250, 1903.

Color.—Impossible to determine as specimens are mounted.

Measurements.—Apterous vivipara.—Body to base of cauda 1 to 1.40 mm.; width .90 mm.; hind tibiae .50 to .70 mm.; hind tarsi .11 mm.; antennae 1 to 1.1 mm.; III .20 to .27 mm.; IV .14 to .20 mm.; V .13 to .19 mm.; VI .10 + .20 to .27 mm.; cornicles .20 to .32 mm. Alate vivipara.—Body to base of cauda 1.2 to 1.5 mm.; hind tibiae .70 mm.; hind tarsi .11 mm.; antennae 1.1 mm.; III .23 to .27 mm.; IV .14 to .16 mm.; V .15 mm.; VI .10 + .25 mm.; cornicles .25 to .28 mm.; cauda .08 mm.; rostrum obtuse, joint IV + V .10 to .11 mm. long, attaining abdomen.

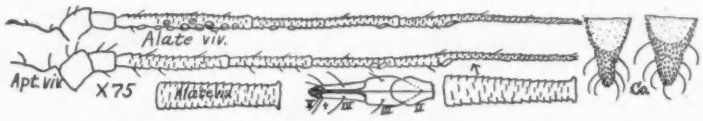


FIG. 113. *Aphis ceanothi.*

Structural Characters.—Secondary sensoria round, convex, with narrow margins, arranged in partly double row along nearly entire length of joint III, 11 to 16 in number, 0 to 3 on IV; absent in apterae. Cornicles cylindrical, with flange, and imbricated. Cauda elongate-conical, longer than broad, with slight tendency to constriction near base, with 3 hairs on a side. Lateral tubercles quite large on prothorax, 1st. and 7th. abdominal segments and, in some examples evident on all abdominal segments. Mediae of fore wings with 2d. fork about .33 the distance from margin of wing to 1st. fork.

Collections.—On flower stems and leaves of *Ceanothus* sp. near Boulder; apterous viviparae July 11 to Sept. 2, alate viviparae July 11; 4 collections, rare.

Taxonomy.—This form differs slightly from the original description in the length of antennal joint III not attaining .31 mm. and the width of the apterous vivipara not attaining 1.19 mm. It may perhaps be a distinct species, but the authors do not feel quite justified in erecting a new species for so small a difference without further information on Clarke's species.

Aphis ceanothi-hirsuti Essig.

Essig, Pom. Jour. Ent., Vol. 3, p. 525, 1911.

Color.—Viviparae.—Reddish-brown, marked with black posterior to cornicles; legs mostly pale; antennae dusky except paler basal portion of joint III; cauda and cornicles black.

Measurements.—Apterous vivipara.—Body to base of cauda 1.8 to 2 mm., by .90 to 1 mm.; hind tibiae .9 mm.; antennae 1.3 mm.; III .35 to .40 mm.; IV .20 to .26 mm.; V .21 to .22 mm.; VI .13 to .15 + .28 to .30 mm.; cornicles .37 to .45 mm.; cauda .07 mm. hard portion, .11 mm. entire length; rostrum obtuse, joint IV + V .11 mm. long, attaining 3d. coxae.

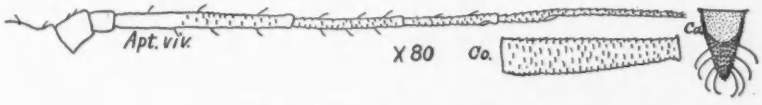


FIG. 114. *Aphis ceanothi-hirsuti.*

Structural Characters.—Cornicles cylindrical, slightly enlarged at base, in some views slightly curved outwards, with slight flange and finely and faintly imbricated. Cauda conical, about as long as broad and with faint constriction near base, bearing 3 or 4 hairs on each side. Lateral tubercles conspicuous on prothorax and 1st. abdominal segment, not evident on other segments.

Collections.—On tender stems and leaves of *Ceanothus velutinus* (?); in Pingree Park; apterous viviparae Aug. 25; one collection.

Taxonomy.—*Aphis ceanothi-hirsuti* Essig is considered by Swain (1919, University of Calif. Pub. in Ent., Vol. 3, p. 97) to be a synonym of *Aphis ceanothi* Clarke. This may be so. We, however, have what appear to be two distinct species on *Ceanothus* and agreeing reasonably well with the two descriptions respectively. Differences noted were the larger size, dark markings, unguis decidedly shorter than cornicle in Essig's species.

Aphis cerasifoliae Fitch.

Fitch, First Rept. Nox. and Ben. Ins. N. Y., p. 131, 1855.

Color.—Viviparae.—Pale yellowish to dark olive-green, with darker green markings on intersegmental lines and on median line anterior to cornicles; dorsum marked with powdery transverse bars; tibiae mostly pale; antennae dusky; cornicles dusky in alatae, pale except tips in apterae.

Measurements.—Apterous vivipara.—Body to base of cauda 2.5 mm. by 1.4 mm.; hind tibiae 1.1 to 1.2 mm.; hind tarsi .11 mm.; antennae

1.66 mm.; III .40 to .59 mm.; IV .30 to .38 mm.; V .28 to .35 mm.; VI .11 + .37 to .52 mm.; cornicles .20 to .35 mm.; cauda .13 mm. hard portion, .17 mm. entire length; rostrum obtuse, joint IV + V broad .10 mm., attaining 2d. coxae. Alate viviparae.—Body to base of cauda 2 to 2.25 mm.; hind tibiae .90 to 1 mm.; antennae 1.35 to 1.70 mm.; III .30 to .43 mm.; IV .22 to .30 mm.; V .20 to .30 mm.; VI .10 + .40 to .45 mm.; cornicles .19 to .24 mm.; cauda .10 mm. hard portion; rostrum attaining between 2d. and 3d. coxae.

Structural Characters.—Secondary sensoria round, flat, arranged in a single row along almost entire length of joint III, 7 to 13 in number; usually none (sometimes 1 to 5 in fall migrants) on IV in alate viviparae;

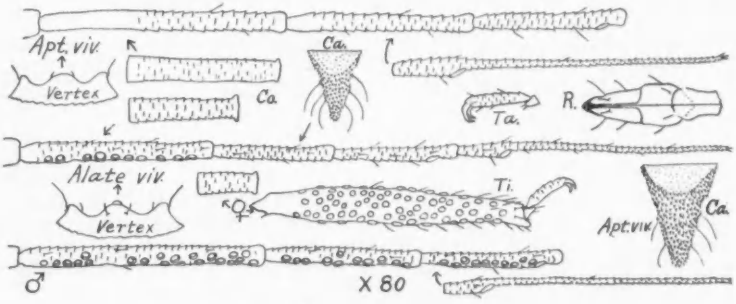


FIG. 115. *Aphis cerasifoliae.*

absent in apterae. Hairs pointed, inconspicuous, sparse, .015 mm. on vertex and antennae, shorter than .5 diameter of antennae; on outer side of hind tibiae .02 to .03 mm., very drooping. Cornicles cylindrical, not enlarged at base and with moderate flanges, imbricated. Cauda conical, a little longer than broad, bearing 2 or 3 hairs on each side. Lateral tubercles evident on prothorax and all abdominal segments. Fore wings with 2d. fork of media about .25 of the distance from margin of wing to 1st. fork. Males alate.

*Collections.*On leaves and twigs of *Prunus melanocarpa* at Fort Collins, Denver, Manitou, Estes Park, Boulder, La Porte, and Steamboat Springs; fundatrices April 18 to 22, apterous viviparae May 13 to Aug. 18, alate viviparae May 26 to Sept. 18, oviparae Sept. 30 and Nov. 2, males Oct. 15 to Nov. 1; 32 collections, very common.

Taxonomy.—This species differs from description by Patch (1914, Me. Agr. Exp. Sta. Bul. 233, p. 260) in sensoria being 7 to 13 instead of "12 to 18" on antennal joint III in alate viviparae. It differs from description by Swain (1919 Univ. of Calif. Pub. in Ent. Vol. 3, p. 97) in the body length 2 to 2.5 mm. instead of "1.50 to 1.65 mm."

Aphis cercocarpi Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. of Amer., Vol. 22, p. 17, 1929.

Color.—Viviparae.—Greenish-black; shining; antennae and legs pale with tips of joints dusky.

Measurements.—Apterous vivipara.—Body to base of cauda 1.3 mm.; hind tibiae .60 to .70 mm.; antennae .95 mm.; III .20 to .30 mm.; IV .11 to .19 mm.; V .10 to .15 mm.; VI .10 + .18 to .24 mm.; cornicles .12 to .18 mm.; cauda .12 mm. entire length, .06 mm. hard portion; rostrum obtuse, joint IV + V slender .11 mm. attaining 3d. coxae. Alate vivipara.—Body to base of cauda 1.33 mm.; hind tibiae .67 mm.; antennae .85 mm.; III .25 mm.; IV .12 mm.; V .12 mm.; VI .10 + .19 mm.; cornicles .10 mm.; cauda .08 mm. entire length, .05 mm. hard portion.

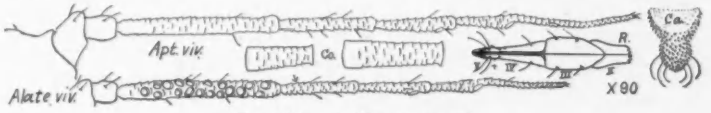


FIG. 116. *Aphis cercocarpi.*

Structural Characters.—Sensoria large, round, scattered over entire length of joint III, 17 in number, none on IV in alate viviparae; absent in apterae. Cornicles cylindrical, imbricated, with narrow flange. Cauda rather globular with distinct constriction near base, bearing 3 curved hairs on each side. Mediae of fore wings with 2d. fork about .33 the distance from margin of wing to 1st. fork. Hairs pointed, inconspicuous, drooping and sparse, .02 to .03 mm. long on vertex, antennae and outside of hind tibiae. Lateral tubercles hardly evident on prothorax and 1st. and 7th. abdominal segments.

Collections.—On leaves and twigs of *Cercocarpus parvifolius* at Loveland, Stove Prairie (above Bellvue) and Ingleside; apterous viviparae Aug. 15 to 21, alate viviparae Aug. 21; 3 collections, rare.

Types in U. S. Nat. Mus., Cat. No. 41461; paratypes in collection of Colo. Agr. Exp. Sta.

Aphis chrysothamnicola (Gillette and Palmer.)

Gillette and Palmer, Ann. Ent. Soc. of Amer., Vol. 22, p. 5, 1929. *Anuraphis.*

Color.—All forms.—Dusky ochre-red or dull blackish-green; legs and antennae pale; cornicles dusky to black.

Measurements.—Apterous summer vivipara.—Body 2 mm. by 1.3 mm.; hind tibiae .85 to 1 mm.; antennae 1.26 mm.; III .23 to .34 mm.; IV .22 to .28 mm.; V .19 to .22 mm.; VI .12 mm. + .21 to .24 mm.; cornicles .16 to .22 mm.; cauda .09 mm. hard portion, 11 mm. entire length; rostrum acute; joint IV + V .23 mm. long, tapering, tip beyond hairs compressed laterally, .01 to .015 mm. wide, .06 to .07 mm. long,

having appearance of distinct 5th. joint, attaining 2d. or 3d. abdominal segment. Alate vivipara.—Same as aptera or with slightly shorter antennae and cornicles.

Structural Characters.—Secondary sensoria circular, 3 to 7 in a single row on III in alate viviparae; absent in apterae. Hairs pointed, hardly longer than diameter of antennae. Cornicles cylindrical, slightly narrower in middle, imbricated, without evident flange, occasionally

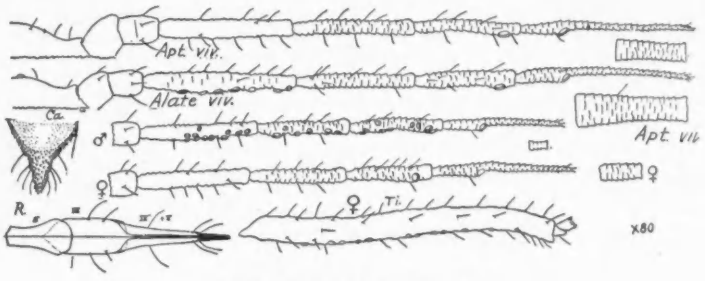


FIG. 117. *Aphis chrysothamnicola.*

bearing a hair on distal half. Cauda conical, rather acute, bearing 3 to 5 hairs on each side and 1 or 2 dorsally. Lateral tubercles large, present on prothorax and 1st., 2d. and 7th. abdominal segments. Fore wings with 2d. fork of mediae .33 to .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae slightly swollen and bearing a row of sensoria on inner side. Males apterous.

Collections.—On leaves and twigs of *Chrysothamnus graveolens* near Fort Collins, Bellvue, Pueblo and Meeker; apterous summer viviparae May 30 to Sept. 24, alate viviparae May 31 to July 10, sexuales Oct. 7 to 29; 23 collections, rather common.

Types in U. S. Nat. Mus., Cat. No. 41455; paratypes in collection of Colo. Agr. Exp. Sta.

Aphis circezandis Fitch.

Fitch, Thirteenth Rept. Nox. & Ben. Ins. N. Y., p. 501, 1870.

Color.—Green mottled, pale to medium, brownish on head; cornicles pale with dark tips in apterae, dusky in alatae; legs and antennae pale.

Measurements.—Apterous vivipara.—Body to base of cauda 1.6 mm. (.9 mm. in small variety); antennae .80 mm.; joint III .15 to .22 mm.; IV .09 to .14 mm.; V .10 to .14 mm.; VI .09 + .14 to .20 mm.; cornicles .10 to .15 mm.; cauda .14 mm. hard portion, .17 mm. entire length; hind tarsi .07 mm.; rostrum obtuse, joint IV + V broad, .08 by .04 mm., attaining about 2d. coxae. Alate vivipara.—Body to base of cauda 1.3 mm.; antennae 1 mm.; joint III .23 to .37 mm.; IV .16 to .25 mm.; V .17 to .22 mm.; VI .11 + .22 to .26 mm.; cornicles .15 to .20 mm.;

cauda .10 mm. hard portion, .14 to .17 mm. entire length; hind tarsi .09 to .10 mm.

Structural Characters.—Hairs on vertex, antennae and tibia sparse, .01 to .015 mm. long, inconspicuous. Sensoria large, circular, arranged in a single row along nearly entire length of III, 4 to 8 in number in alate viviparae; absent in apterae. Cornicles cylindrical, slightly narrowed in middle, rather sparsely imbricated, with slight flange.

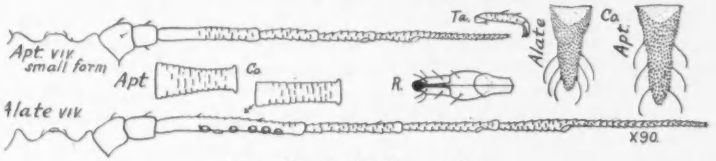


FIG. 118. *Aphis circezandis.*

Cauda elongate-cylindrical with slightly broader base, and slight tendency to constriction next to base; bearing about 3 hairs on each side. Lateral tubercles evident on prothorax and 1st. and 7th. abdominal segments. Fore wings with 2d. branch of media quite short, sometimes obsolete, rarely more than .33 of distance from margin of wing to 1st. fork. Sexuales not taken.

Collections.—On leaves and stems of *Galium* sp. near Log Cabin and Eldora; apterous summer viviparae June 29 and Aug. 21, alate viviparae June 25 to July 27; 4 collections, apparently rare.

Taxonomy.—Fitch's type (in bad condition) have been determined as *gossypii* Glover by A. C. Baker (Proc. Ent. Soc. Wash., Vol. 20, p. 130, 1918). This may be the case, but the authors feel reluctant to so determine the Colorado examples without further biological study. The fact that the cornicles are rarely longer than the cauda and the unguis has not once been found longer than III, often shorter, in the 50 specimens in the Colorado collection, would seem to separate the Colorado form, on *Galium*, from *gossypii*. In *A. gossypii* the spur is usually longer and never shorter than III, and cornicles are considerably longer than cauda. Furthermore, as far as we know, *A. gossypii* has not been reported on *Galium*. These facts indicate that *circezandis* may be distinct.

Aphis cornifoliae Fitch.

Fitch, Rept. Reg. Univ. St. N. Y. Cab. Nat. Hist., p. 65, 1851.

For further description see Hottes and Frison "Aphiidae of Ill." Div. Nat. Hist. Surv., Vol. 19, p. 189, 1931.

Color.—Apterous summer vivipara.—Greenish-black; legs pale; cornicles and cauda dusky to black.

Measurements.—Apterous summer vivipara.—Body .90 to 1.20 mm.; hind tibiae .60 mm.; hind tarsi .10 mm.; antennae .90 to 1.05 mm.; III .21 to .27 mm.; IV .15 to .19 mm.; V .16 to .19 mm.; VI .11 + .25 to .29 mm.; cornicles .22 to .26 mm.; cauda .07 to .08 mm. hard portion, .11 to .12 mm. entire length but slightly longer than wide; rostrum obtuse, joint IV + V .10 mm. long, attaining 3d. coxae.

Structural Characters.—Secondary sensoria absent in apterae. Hairs pointed, drooping, .03 mm. long on vertex, and outer side of hind tibiae; .02 mm. long on antennae. Cornicles cylindrical, with flanges, imbricated. Cauda short, cylindrical to conical, bluntly rounded at tip, bearing about 4 hairs on each side. Lateral tubercles well developed on

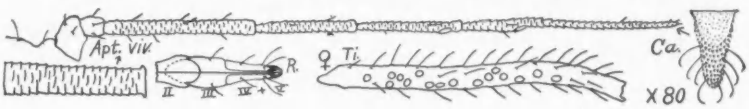


FIG. 119. *Aphis cornifoliae.*

prothorax and 1st. and 7th. abdominal segments. Oviparae with hind tibiae hardly perceptibly swollen on proximal .66 of length and bearing about 16 flat sensoria scattered along nearly all of tibia. Males apterous.

Collections.—On leaves and stems of *Svida stolonifera* in foothills near Bellvue; apterous summer viviparae and sexuales Oct. 8; one collection, rare.

Taxonomy.—The determination of these specimens was confirmed by comparison with specimens sent by Hottes and Frison. Several other collections were taken on the same host which resemble the above described form but differ in shorter cornicles and unguis which is .16 to .18 mm. long, shorter than antennal III, also hairs are erect and .05 mm. long on antennae and .07 mm. long on hind tibiae. Whether these are only variations of the species or a distinct form is uncertain at present.

Aphis debilicornis (Gillette and Palmer).

Gillette and Palmer, Ann. Ent. Soc., Amer. Vol. 22, p. 10, 1929. *Anuraphis.*

Color.—Viviparae.—Dark olive-buff; dusky on head, pronotum and lateral areas of body, and dorsal dashes on terminal abdominal segments; cornicles, cauda, antennae and most of legs dusky.

Measurements.—Apterous summer vivipara.*—Body to base of cauda 2 mm.; hind tibiae 1 mm.; hind tarsi .15 mm.; antennae 1.1 mm.; III .26 to .35 mm.; IV .15 to .18 mm.; V .14 to .17 mm.; VI .12 + .16 to .19 mm.; cornicles .10 to .14 mm.; cauda .10 mm. hard portion. Alate vivipara.—Body to base of cauda 2.6 mm.; hind tibiae 1.1 mm.; hind

*A form varying from .8 to equal to the size of the smallest typical form in all measurements and showing no secondary sensoria but otherwise indistinguishable, was found mingled in several of the colonies.

tarsi .15 mm.; antennae 1.1 mm.; III .32 to .35 mm.; IV .18 to .20 mm.; V .17 mm.; VI .13 + .18 to .20 mm.; cornicles .10 to .13 mm.; cauda .09 to .10 mm. hard portion, .14 mm. entire length; rostrum obtuse, joint IV + V slender, .15 mm. long, attaining 2d. coxae.

Structural Characters.—Secondary sensoria round, convex, somewhat tuberculate, scattered over entire length of joint III, 20 to 30 in number; on IV, 6 or 7; on V, 1 to 3; on apterous viviparae* on III, 1 to 20; on IV, 1 to 5; on V, 0, cylindrical, not expanded at base, imbricated and without flanges, slender and weak, not broader than hind tibiae or joint III of antennae. Cauda blunt, elongate conical, bearing about 8 hairs on a side. Hairs pointed, sparse, semi-erect to erect, .03 mm. on vertex, antennae and tibiae. Lateral tubercles present on prothorax and 1st. and 7th. abdominal segments. Mediae of fore wings with 2d. fork

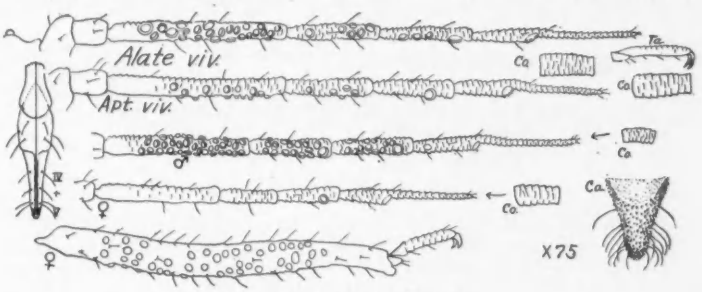


FIG. 120. *Aphis debilicornis.*

about .33 to .5 or slightly more of the distance from margin of wing to 1st. fork. Oviparae with hind tibiae but slightly swollen and bearing about 40 rather large sensoria along nearly entire length. Males alate.

Collections.—On curled leaves and stems of *Helianthus annuus* and *tuberosus*, at Fort Collins, Colorado Springs and Loveland; apterous summer viviparae July 2 to Sept. 26, alate viviparae July 5 to Sept. 24, males Aug. 31 to Sept. 29, oviparae Sept. 17 to 29; 12 collections, not common in Colorado but apparently widely distributed, as specimens have been received from Iowa, Minnesota, Kansas and New Jersey.

Type in collection of the U. S. Nat. Mus., Cat. No. 41458; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species appears to be closely allied to *A. middletonii* Thos. but is distinguished by the more abundant sensoria on antennal III, the weaker cornicles usually shorter than the hind tarsi (exclusive of claws) and not wider than hind tibiae, and the habit of living on leaves instead of on roots.

*In the small form, above mentioned in foot note, sensoria were lacking.

Aphis eriogoni Cowen.

Gillette and Baker, "Hemip. Colo." Agr. Exp. Sta. Bul. 31, p. 119, 1895.

Color.—Viviparae.—Yellowish olive-green mottled with olive-yellow in alate viviparae;* black or blackish in apterae with pattern of white reticulation covering all of dorsum except median portions of abdominal segments 2 and 3, entire dorsum of 5, and dorsolateral areas on mesonotum; dusky markings on the tips of antennal and leg joints, cornicles, cauda; and in alatae dorsal dashes on abdominal segments 6, 7 and 8, and lateral areas of all segments.

Measurements.—Apterous summer vivipara.—Body length 1.65 to 2 mm.; hind tibiae .60 to 1.1 mm.; hind tarsi .10 to .12 mm.; antennae .8 to 1.1 mm.; III .24 to .37 mm.; IV .14 to .24 mm.; V .14 to .22 mm.; VI .09 to .13 + .17 to .20 mm.; cornicles .07 to .12 mm.; cauda .04 mm.

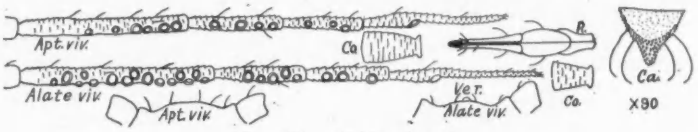


FIG. 121. *Aphis eriogoni.*

on median line of hard portion, entire length .09 mm.; rostrum acute, joint IV + V slender, .16 mm. by .045 mm. at base, attaining 2d. coxae. Alate vivipara.—Body length 1.25 to 1.50 mm.; hind tibiae .6 to .8 mm.; hind tarsi .10 to .12 mm.; antennae 1.1 mm.; III .30 to .40 mm.; IV .17 to .20 mm.; V .14 to .18 mm.; VI .09 to .12 + .16 to .20 mm.; cornicles .06 to .08, rarely .10 mm.; cauda .04 mm. on hard portion.

Structural Characters.—Secondary sensoria round, large, diameter sometimes almost equal to width of antenna, arranged in two irregular rows along almost entire length of joint, 15 to 18 on III, 5 to 6 on IV, 3 to 4 on V in alate viviparae; in apterous viviparae 5 to 6 on III, 4 on IV, 2 on V. Cornicles cylindrical, broader at base and distinctly constricted next to strong flange, slightly imbricated. Cauda conical, acute, with 2 or 3 hairs on each side. Lateral tubercles evident on prothorax, and 1st. and 7th. abdominal segments. Hairs pointed, .03 to .05 mm. long, drooping to semierect. Mediae of fore wings with 2d. fork .5 the distance from margin to 1st. fork.

Collections.—On leaves and stems of *Eriogonum alatum, inflatum, bakeri, effusum,* and *umbellatum,* at Boulder, Eldora, Clifton, Elkhorn, Estes Park, Rist Canon near Bellvue, and Owl Canon in Larimer County; apterous summer viviparae June 2 to Sept. 6, alate viviparae May 31 to Sept. 6, sexuales not taken; 34 collections; fairly common.

*A few specimens were found with short unguis, .12 to .14 mm. long and color in alatae yellowish-brown with broken dashes on all abdominal segments. It is doubtful whether this form should be separated from *eriogoni*, but material now at hand is insufficient to decide the question.

Aphis filifoliae Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 21, p. 9, 1928. *Anuraphis.*

Color.—Apterous vivipara.—Brownish-amber to dark brown or blackish with lighter pattern covered with white reticulation on pronotum, 1st., 6th., 7th., borders of 8th., and median portion of 5th. abdominal segments, and lateral surface of entire body; legs and antennae pale buff except tips; cornicles black; head dark brown.

Measurements.—Apterous vivipara.—Body 1.10 mm. by .50 mm.; hind tibiae .35 mm.; antennae .50 mm.; III .10 to .14 mm.; IV .08 to .09 mm.; V .08 to .10 mm.; VI .08 to .09 + .08 to .09 mm.; cornicles .075 to .11 mm.; cauda .04 mm. hard portion, .075 mm. entire length; hind tarsi .09 mm.; rostrum acute, joint IV + V .13 mm. long, tapering,

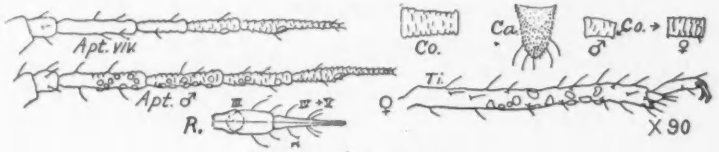


FIG. 122. *Aphis filifoliae.*

tip beyond hairs compressed laterally making ventral aspect quite slender .01 to .015 mm. wide and .06 mm. long, and resembling distinct 5th. joint.

Structural Characters.—Antennae bearing pointed hairs whose length is subequal to diameter of antenna. Sensoria not observed as no alate viviparae have been taken. Cornicles cylindrical or slightly tapering, imbricated, with slight flange. Cauda slightly longer than broad, parallel-sided and rounded at tip, bearing 2 curved hairs on each side and 1 or 2 dorsal ones. Lateral tubercles well developed on prothorax and 1st. and 7th. abdominal segments. Males apterous. Oviparae with hind tibiae not noticeably swollen but bearing 4 to 12 large irregular sensoria in middle portion.

Collections.—On leaves and stems of *Artemisia filifolia* and *tridentata* at Fort Collins, Denver, Estes Park and Laramie-Poudre Tunnel; apterous viviparae July 10 to Aug. 12, sexuales Oct. 8; 7 collections, often in large numbers; little collecting has been done in localities where the host occurs.

Types in U. S. Nat. Mus., Cat. No. 41975; paratypes in collection of Colo. Agr. Exp. Sta.

Aphis forbesi Weed.

Weed, Bul. Ohio Agr. Exp. Sta., Vol. 2, p. 148, 1889.

Color.—Vivipara.—Dark green, mottled with yellowish; cornicles yellowish to dusky. Alate with dark lateral areas and dorsal bands on abdominal segments 6, 7 and 8; cauda dusky.

Measurements.—Apterous summer vivipara.—Body to base of cauda 1 to 1.2 mm.; hind tibiae .50 to .70 mm.; hind tarsi .08 to .09 mm.; antennae .80 to .90 mm.; III .17 to .19 mm., (when anastomosed with IV .23 to .33 mm.); IV .11 to .13 mm.; V .12 to .13 mm.; VI .09 + .19 to .26 mm.; cornicles .17 to .27 mm.; cauda .07 mm. hard portion, .11 mm. entire length; rostrum obtuse, joint IV + V .13 mm. long, .05 mm. wide at base, attaining abdomen. Alate vivipara.—Body length to base of cauda 1 to 1.3 mm.; hind tibiae .65 to .75 mm.; hind tarsi .09 mm.; antennae .70 to .90 mm.; III .17 to .22 mm. (sometimes anastomosed with IV); IV .12 to .17 mm.; V .13 to .15 mm.; VI .10 + .25 to .31 mm.; cornicles .15 to .22 mm.; cauda .07 median line on hard portion, .12 mm. entire length.

FIG. 123. *Aphis forbesi.*

Structural Characters.—Sensoria round, slightly tuberculate, arranged in a single row on III of alate viviparae, 2 to 4 in number, absent in apterae. Cornicles cylindrical, slightly tapering, with narrow flange, and imbricated. Cauda rounded, parallel-sided and somewhat constricted near base, bearing 3 or 4 hairs on a side. Lateral tubercles blunt, evident on prothorax, and 1st. and 7th. abdominal segments. Mediae of fore wings with 2d. fork variable from obsolete to .5 the distance from margin of wing to 1st. fork.

Collections.—On roots and crown of (tame strawberry) *Fragaria* sp. at Greeley and Fort Collins; apterous summer viviparae July 10 to Sept. 19, alate viviparae July 14 and Oct. 17; 10 collections, abundant in only one case.

Taxonomy.—*Aphis forbesi* is separated from *A. gossypii* by the longer unguis, 1.25 to 1.33 times joint III instead of subequal; sensoria 2 to 4 on III of alatae instead of 7 to 10; shorter cauda, hard portion shorter than base of VI instead of equal or longer and rostrum attaining abdomen instead of 2d. coxae.

Aphis frangulae Kaltenbach.

Kaltenbach, Ent. Zeit. 6th. year, p. 18, 1845 and Mon. Pflanz., p. 64, 1843. *A. rhamni* (syn. *Aphis nepetae* Kalt. Mon. Pflanz., p. 77, 1843.)

Color.—Viviparae.—Dark green; cauda and cornicles blackish; legs dusky yellow.

Measurements.—Alate vivipara.—Body 1 to 1.2 mm.; hind tibiae .63 to .70 mm.; hind tarsi .08 mm.; antennae .90 to .95 mm.; III .22 to

.24 mm.; IV .12 to .14 mm.; V .11 to .13 mm.; VI .09 to .10 + .23 to .27 mm.; cornicles .15 to .19 mm.; cauda .09 mm. hard portion, .14 mm. entire length; rostrum obtuse, joint IV + V .09 mm. long, attaining 3d. coxae. Apterous summer vivipara.—Same as alata except the following: cornicles .20 to .25 mm. and hind tibiae .58 to .63 mm.

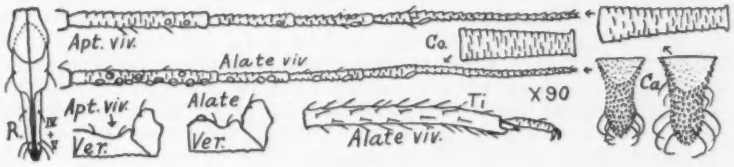


FIG. 124. *Aphis frangulae.*

Structural Characters.—Secondary sensoria circular, rather large, arranged in irregular double row 8 to 14 in number along entire III, 2 to 4 on IV, 0 to 1 on V; very small in apterae 0 to 3 on distal half of III, 0 to 1 near tip on IV. Hairs pointed, rather sparse, on vertex and antennae .01 to .02 mm. long; on outer side of hind tibiae drooping .02 to .03 mm.; on cauda .05 mm. long and curved. Cornicles cylindrical or slightly tapering, with flange and imbricated. Cauda cylindrical with slight neck, bearing 3 pairs of stout curved hairs distally and occasionally 2 short ones near base. Fore wings with 2d. fork of media .25 to .45 the distance from margin of wing to 1st. fork.

Collections.—On *Nepeta cataria*, near Fort Collins; apterous and alate viviparae Sept. 5; only 1 collection, but abundant in this case.

Acknowledgments are due to D. Hille Ris Lambers of Wageningen, Holland for aid in determination of this form by comparison of our specimens with European material.

Aphis fraserae Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 22, p. 16, 1929.

Color.—Viviparae.—Yellowish-green, mottled with dark green, often blackish; antennae and legs pale brownish, shading to dusky distally; cornicles and cauda dusky to black.

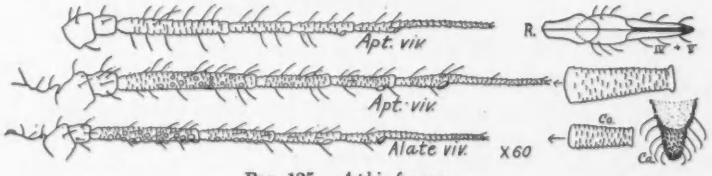


FIG. 125. *Aphis fraserae.*

Measurements.—Apterous summer vivipara.—Body to base of cauda 2 mm.; hind tibiae .83 mm.; hind tarsi .11 mm.; antennae 1.16 mm.;

III .27 to .34 mm.; IV .16 to .23 mm.; V .14 to .19 mm.; VI .12 mm. + .18 to .25 mm.; cornicles .22 to .30 mm.; cauda .15 mm. entire length, .07 mm. hard portion; rostrum obtuse, joint IV + V .16 to .17 mm., attaining 3d. coxae or 1st. abdominal segment. Alate vivipara.—Body to base of cauda 1.66 mm.; hind tibiae .83 mm.; hind tarsi .11 mm.; antennae 1.12 mm.; III .30 mm.; IV .18 mm.; V .17 mm.; VI .13 + .23 mm.; cornicles .20 mm.; cauda entire length .14 mm., hard portion .07 mm.

Structural Characters.—Secondary sensoria round, irregular in size, and scattered over most of joint III, 24 in number; on IV, 1 to 7; usually lacking in apterae, but occasional individuals have 9 to 14 on III, and 0 to 2 on IV. Cornicles cylindrical or slightly tapering, imbricated, and with flange. Cauda blunt, almost parallel sided, bearing 5 or 6 hairs on each side. Hairs pointed, rather sparse, .03 to .05 mm. long and nearly erect. Lateral tubercles evident on prothorax and 1st. and 7th. abdominal segments, well developed. Mediae of fore wings with 2d. fork from .33 to .66 the distance from margin of wing to 1st. fork.

Collections.—On flower pedicels of *Frasera speciosa*, in hills near Bellvue, Boulder, Ward and Pingree Park; apterous summer viviparae May 28 to Sept. 2, alate viviparae June 9 to Aug. 12; 12 collections, rather common.

Types in collection of U. S. Nat. Mus., Cat. No. 41460; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species seems to be very close to *Aphis lugentis* Will. but differs in the darker appendages, smaller body, longer rostrum; also unguis is usually longer than IV instead of shorter as in *lugentis*.

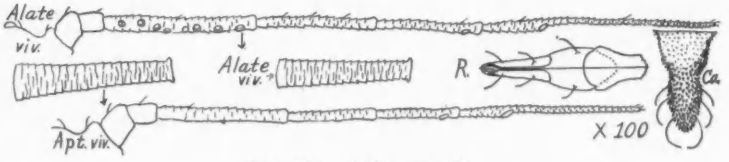


FIG. 126. *Aphis gossypii.*

Aphis gossypii Glover.

Glover, Rept. Comm. Agr. U. S. A. for 1876, p. 36, 1877. Also U. S. Pat. Off. Agr. Rept., 1854, p. 62, and 1855, p. 68, "*Aphis* sp."

For fuller description see Batchelder, Ann. Ent. Soc. Amer., Vol. 20, p. 263, 1927.

Color.—Viviparae.—Pale yellow to pale sordid or yellowish-green to mottled blackish-green without dusky markings, except on lateral areas; legs pale; cornicles black; nymphs of alatae green with dorsum of abdomen flesh color, powdered on head and thorax and usually tessellated on abdomen.

Measurements.—Apterous summer vivipara.—Body to base of cauda 1.1 to 1.8 mm.; antennae .65 to .80 mm. (often 5-jointed); III .17 to .24 mm.; IV .10 to .18 mm.; V .10 to .18 mm.; VI .09 + .18 to .30 mm.; cornicles .20 to .30 mm.; cauda .12 to .15 mm. hard portion, entire length .17 mm.; hind tarsi .08 to .10 mm. Small form.—Body .9 to 1 mm.; antenna .67 mm.; III .12 to .17 mm.; IV .08 to .10 mm.; V .09 to .10 mm.; VI .08 + .23 mm.; hind tibiae .30 mm. Alate vivipara.—Body to base of cauda 1.1 to 1.7 mm.; antennae .80 to 1 mm.; III .20 to .35 mm.; IV .10 to .23 mm.; V .11 to .21 mm.; VI .10 + .20 to .32 mm.; cornicles .15 to .29 mm.; cauda .10 to .12 mm. hard portion, entire length .15 mm.; hind tarsi .08 to .09 mm.; rostrum obtuse, joint IV + V .10 to .11 mm. long, attaining 2d. to 3d. coxae.

Structural Characters.—Secondary sensoria large, circular, arranged in a single row, 7 to 10 in number on III, rarely 1 or 2 on IV in alate viviparae; absent in apterae. Hairs on antennae pointed, minute, and sparse. Cornicles cylindrical, with slight flange and imbricated. Cauda elongated, cylindrical to spoon-shaped, constricted above middle, bearing 2 or 3 curved hairs on a side. Lateral tubercles evident on prothorax and 1st. and 7th. abdominal segments. Fore wings with 2d. branch of media hardly .33 the distance from margin of wing to 1st. fork.

Collections.—On leaves and twigs of *Amaranthus* sp., *Asclepias* sp., *Begonia* sp., *Capsella bursa-pastoris*, *Catalpa* sp., *Cucumis mela*, and *sativus*, *Cucurbita pepo*, *Echinocystis lobata*, *Hibiscus* sp., *Phaseolus* sp., *Rumex crispus*, *Solanum melongena*, *Sophia* sp., and *Verbena bipinnatifida* at Fort Collins, Denver, Rocky Ford, Canon City, Sugar City and Greeley; alate and apterous viviparae Mar. to Nov., sexuales not taken; 60 collections, very abundant.

Taxonomy.—This species is suspected of being a synonym of *Aphis sedi* Kaltenbach (Patch, Me. Agr. Exp. Sta., Bul. 326, p. 193, 1925). In Colorado, *Sedum* is recorded only in the hills and mountains and thus far no aphids on this host appear in the collection.

Aphis gregalis Knowlton.

Knowlton, Ann. Ent. Soc. of Amer., Vol. 21, p. 259, 1928.

Color.—Viviparae.—Green with dusky dorsal bands especially on 4th. and 5th. abdominal segments; legs and antennae pale; cornicles dusky.

Measurements.—Apterous summer viviparae.—Body 1.2 to 1.8 mm.; hind tibiae .45 to .65 mm.; hind tarsi .12 mm.; antennae .60 to .85 mm.; III .16 to .21 mm.; IV .09 to .12 mm.; V .09 to .13 mm.; VI .10 + .11 to .14 mm.; cornicles .10 to .17 mm.; cauda, hard portion .05 to .07 mm.; entire length .10 to .12 mm. Alate vivipara.—Body 1.50 mm.; hind tibiae .75 mm.; hind tarsi .13 mm.; antennae .85 mm.; III .20 to .23 mm.; IV .15 mm.; V .15 mm.; VI .10 + .15 mm.; cornicles .13 mm.; cauda

hard portion .07 mm., entire length .12 mm.; rostrum obtuse, joint IV + V slender, .13 mm. long, attaining between 2d. and 3d. coxae.

Structural Characters.—Secondary sensoria round, arranged in rather even row, 7 in number, along almost entire length of antennal joint III, 1 to 2 on IV; in apterous viviparae 1 to 6 on III, 0 to 1 on IV. Cornicles cylindrical, imbricated, without flange, sometimes slightly bent inwards. Cauda conical, blunt, bearing 4 or 5 hairs on a side. Mediae of fore wings with 2d. fork from hardly .5 to nearly .66 the distance from margin of wing to 1st. fork. Lateral tubercles well developed. Males apterous. Oviparae with hind tibiae swollen over most of length and bearing numerous sensoria.

Collections.—On leaves and tender tips of *Chrysothamnus* sp. at Meeker, Craig, Sargent and Ridgway; apterous summer viviparae July 26 to Aug. 6 alate viviparae Aug. 6 and 7; 6 collections. Collections listed in original description of *A. ornata* Gillette and Palmer from western slope of Colorado are now considered as belong to this species.

Aphis helianthi Monell.

Monell, Bul. U. S. Geol. & Geog. Surv. Terr., Vol. 5, No. 1, p. 26, 1879.

Color.—Viviparae.—Yellowish-green mottled with medium to dark green over dorsum and with dark green band on 4th. abdominal segment

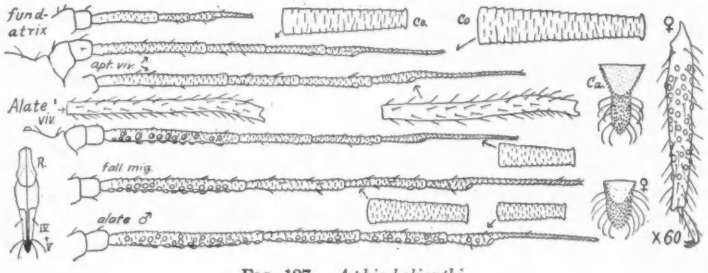


FIG. 127. *Aphis helianthi.*

and broken bands on segments 2, 3, and 4; dusky markings on lateral areas of abdomen and dorsum of 6th., 7th., and 8th. abdominal segments in alatae; covered with very slight powder; cornicles and antennae distally, dusky; legs pale yellowish with tips of tibiae and tarsi dusky; pupae yellowish-brown and tessellated; fall migrants and males often yellow-brown.

Measurements.—Apterous summer vivipara.—Body to base of cauda 1.5 to 1.9 mm.; hind tibiae .85 mm.; hind tarsi .12 mm.; antennae 1.1 to 1.2 mm.; joint III .30 to .37 mm.; IV .16 to .19 mm.; V .17 to .20 mm.; VI .11 + .21 to .27 mm.; cornicles .30 to .40 mm.; cauda .14 mm. entire length, .09 mm. hard portion on median line. Alate vivipara.—

Body to base of cauda 1.45 to 2 mm.; hind tibiae .90 mm.; hind tarsi .10 to .12 mm.; antennae 1.3 mm.; joint III .28 to .40 mm.; IV .15 to .22 mm.; V .14 to .20 mm.; VI .10 to .12 + .24 to .30 mm.; cornicles .17 to .30 mm.; cauda .09 mm. on median line of hard portion, .14 mm. entire length; rostrum obtuse, joint IV + V moderately slender, .11 mm. long, hardly attaining 2d. coxae.

Structural Characters.—Secondary sensoria round, slightly convex, hardly tuberculate, scattered over entire length of joint III mostly on posterior side, 15 to 32 in number, rarely 1 or 2 on IV in alate viviparae; absent in apterae. Cornicles cylindrical or slightly tapering, imbricated, and with slight flange. Cauda elongate, nearly parallel-sided with tendency to constriction near base, and bearing 5 or 6 hairs on a side. Hairs pointed, drooping, sparse, and short, about .02 mm. long on vertex, antennae and outer side of hind tibiae. Lateral tubercles evident on prothorax, and 1st. and 7th. abdominal segments. Fore wings with 2d. fork of media about .33 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae swollen along entire length and thickly covered with round, convex sensoria. Males alate.

Collections.—Found wintering on bark of twigs and leaves of *Svida stolonifera*, leaving with second generation in spring and returning in fall with alate males and sexuparae which deposit the oviparae; passing the summer on leaves of *Helianthus annuus* and sp. both wild and cultivated, also *Ambrosia trifida* and *artemisifolia*, *Allionia linearis* and *nyctaginea*, *Asclepias* sp., *Iva xanthifolia*, *Cirsium* sp.* and *Urtica gracilis* generally throughout the state; fundatrices March 30 to May 6 on winter host, apterous summer viviparae June 4 to Nov. 9 on summer hosts, alate viviparae April 19 to May 4 and Aug. 8 to Oct. 1 on winter host, June 4 to Nov. 9 on summer hosts; oviparae Sept. 6 to Oct. 24 on winter host, alate males Sept. 15 to Oct. 24 on both winter and summer hosts; slightly curling young leaves of *Svida* in spring but no tendency to curl later either on summer hosts or *Svida* in fall; about 150 collections, very common.

Taxonomy.—The determination of this form is based on metatypes and detailed notes from Mr. Monell received in correspondence. He also determined Colorado specimens sent to him as his species. This is the species referred to as *Aphis cornifoliae* Fitch by Gillette (Jo. Ec. Ent., Vol. 3, p. 405, 1910).

The statements in original description that third joint of antenna is "as long as the preceding taken together" and

*The examples from *Cirsium* sp. differ from *A. carduella* Walsh according to Hottes and Frison ("Aph. Ill.," Nat. Hist. Survey Bul., Vol. 19, p. 183) in longer antennal joints and cornicles. They are inseparable from *A. helianthi* though the antennae, cornicles and body are usually shorter than the average in examples from *Helianthus* and tibial hairs usually longer.

"nectaries . . . . . less than twice the length of the tarsi" are evidently errors as they differ from characters found in over a dozen metatypes and notes received from Mr. Monell.

Since the original description is incomplete and even misleading, one of the slides of metatypes in the collection of the Colo. Agr. Exp. Sta. has been deposited in the collection of the U. S. National Museum.

Aphis oxybaphi Oestlund appears to be structurally inseparable from *A. helianthi*, differing only in the yellow color and perhaps averaging a little larger in size. Several years work in experimental transfers have demonstrated that this form thrives equally well either on *Helianthus* or *Oxybaphus*. In exchange of host the yellow color appears in most of the individuals after several generations on *Oxybaphus* and the green similarly on *Helianthus*. Individuals from both hosts take equally well to *Svida* as winter hosts. *Aphis oxybaphi* Oestlund is accordingly here placed as a snyonym of *Aphis helianthi Monell*.

Aphis yuccae Cowen appears structurally identical with *A. oxybaphi*. Experimental transfers, though not as extensively carried out as in the case of *A. oxybaphi* seem to indicate that *A. yuccae* Cowen is at least a form of *A. helianthi*. *A. yuccicola* Williams has already been determined a synonym of *A. yuccae* Cowen by J. J. Davis (Univ. Studies, Lincoln, Nebraska, Vol. 11, p. 22, 1911).

Aphis gillettei Cowen is undoubtedly a synonym of *A. helianthi*.

Aphis helichrysi Kalt.

Kaltenbach, Mon. der. Pflanzenlause, p. 102, 1843.

For fuller description see Oestlund, Geol. and Nat. Hist. Surv. Minn., Bul. 4, p. 57, 1887. *Aphis marutae*.

Color.—Viviparae.—Yellowish to olive-green to rusty; alatae with green abdomen marked with black lateral areas and dorsal bands which are united into dorsal patch on segments III, IV and V; cornicles and antennae black; appendages pale in apterae.

Measurements.—Apterous vivipara.—Body 1.2 to 1.4 mm.; hind tibiae .45 mm.; hind tarsi .10 mm., antennae .77 to .83 mm.; III .14 to .20 mm.; IV .10 to .15 mm.; V .08 to .10 mm.; .06 to .08 + .15 to .24 mm.; cornicles .15 mm.; cauda .09 mm. hard portion; rostrum attaining 3d. coxae. Alate vivipara.—Body 1.60 mm.; hind tibiae 1 mm.; hind tarsi .09 mm.; antennae 1.2 to 1.5 mm.; III .24 to .40 mm.; IV .11 to .20 mm.; V .11 to .16 mm.; VI .10 + .24 to .40 mm.; cornicles .10 to .17 mm.; cauda .07 mm. hard portion, .10 mm. entire length; rostrum obtuse, joint IV + V slender, .12 mm. long, hardly attaining 3d. coxae.

Structural Characters.—Secondary sensoria in alate viviparae rather large, scattered along whole length of III, 12 to 25 in number, 1 to 9 on IV; absent in apterae. Hairs on antennae inconspicuous, shorter than diameter of joints. Cornicles cylindrical, without noticeable imbrications. Cauda short, conical, obtuse, about as long as broad in apterae, slightly longer in alate viviparae with 2 or 3 hairs on each side.

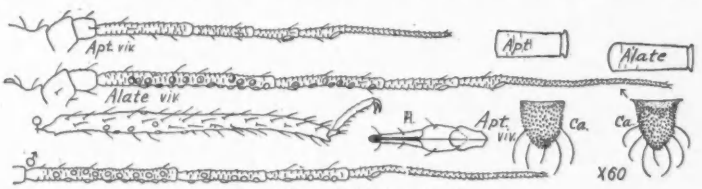


FIG. 128. *Aphis helichrysi.*

Mediae of fore wings with 2d. fork .33 to .5 the distance from margin of wing to 1st. fork. Lateral tubercles minute on pronotum, present but inconspicuous on abdomen.* Males apterous. Oviparae with hind tibiae slightly swollen on proximal third and bearing about 7 flat sensoria.

Collections.—On leaves and stems of *Achillea millefolium*, *Ambrosia artemisiaefolia*, *Capsella bursa-pastoris*, *Carduus* sp. *Cineraria* sp., *Erigeron canadensis*, *Eupatorium* sp., *Malva rotundifolia*, *Mertensia* sp., *Onosmodium occidentale*, *Prunus* sp., *Pyrus Malus*, *Phacelia* sp., *Senecio* sp., *Tanacetum balsamita; Urtica* sp. and *Vinca* sp. at Fort Collins, La Porte, and Boulder; apterous summer viviparae May 16 to Dec. 3 outdoors, and all months of the year in the greenhouse, alate viviparae Mar. 29 to Dec. 5 (also taken Jan. 29 in laboratory), sexuales Oct. 16, on *Onosmodium occidentale;* 43 collections, very common.

Taxonomy.—This species is considered to be the *Aphis padi* of Linnaeus by Theobald (Aph. Gr. Br., Vol. 2, p. 403, 1927). Since the usage of *A. padi* L. has been so confused it seems better to retain Kaltenbach's name, for the sake of clarity at least.

Aphis heraclella Davis.

Davis, Can. Ent., Vol. 51, p. 228, 1919. New name for *Aphis heraclii* Cowen. Gillette and Baker, "Hemip. of Colo." Colo. Agr. Exp. Sta., Bul. 31, p. 120, 1895.

Color.—Viviparae.—Deep green mottled with yellowish-green, alatae marked with dusky on lateral areas and dorsal dashes on abdominal

*Van der Goot (Hollandischen Blattlause, p. 256, 1915) says *A. helichrysi* Kalt. is without lateral tubercles, but specimens received from him agree with ours in lateral tubercles.

segment 6, 7 and 8; cauda and cornicles dusky; legs mostly pale. Nymphs of alatae brownish-yellow marked with green dorsolateral spots on abdominal segments 1 to 4, and solid band on segment 5; tesselated with white.

Measurements.—Apterous vivipara.—Body to base of cauda 1.50 to 1.70 mm.; hind tibiae .75 to .90 mm.; hind tarsi .14 mm.; antennae .95 to 1.33 mm.; III .27 to .50 mm.; IV .13 to .27 mm.; V .16 to .22 mm.; VI .10 to .14 + .22 to .31 mm.; cornicles .21 to .40 mm.; cauda .10 mm. hard portion, .17 mm. entire length; rostrum obtuse, joint IV + V moderately slender, .12 mm. long, attaining between 2d. and 3d. coxae. Alate vivipara.—Body to base of cauda 1.40 to 1.90 mm.; hind tibiae .90 to 1 mm.; hind tarsi .14 mm.; antennae 1.20 to 1.36 mm.; III .31 to .49 mm.; IV .19 to .30 mm.; V .17 to .26 mm.; VI .10 to .13 + .25 to .35 mm.; cornicles .16 to .31 mm.; cauda .09 mm. hard portion, .15 mm. entire length.

Structural Characters.—Secondary sensoria circular, tuberculate, scattered in two irregular rows over entire joint III, 15 to 28 in number, 0 on IV and V in alate viviparae; absent in apterous viviparae. Hairs pointed, sparse, .02 to .03 mm. long on antennae and vertex; on cauda .06 mm. and curved. Cornicles cylindrical or slightly tapering, with flange and rather closely imbricated. Lateral tubercles small. Mediae of fore wings with 2d. fork between .33 and .5 the distance from margin of wing to 1st. fork. Sexuales not taken.

Collections.—On leaves and stems of *Heracleum lanatum*, *Cicuta occidentalis*, *Pastinaca sativa* and *Apium graveolens* near Fort Collins, Eaton, Long Cabin, Meeker, Antonito and Denver; apterous summer viviparae June 28 to Oct. 6, alate viviparae July 9 to Oct. 6; 26 collections, common.

Taxonomy.—This species appears to be structurally indistinguishable from *A. helianthi* unless an apparent tendency to longer antennal joints and cornicles and darker green coloration can be considered of sufficient value for separation. As no experimental work in the way of transfers has been carried on by the writers these forms are here tentatively given as distinct awaiting further investigation.

Aphis hermistonii Wilson.

Wilson, Trans. Amer. Ent. Soc., Vol. 41, p. 93, 1915.

For fuller description and discussion on taxonomy see Gillette and Palmer, Ann. Ent. Soc. of Am., Vol. 21, pp. 11 and 13, 1928.

Color.—Viviparae.—Green with white powdery markings.

Measurements.—Apterous summer vivipara.—Body to base of cauda 1.35 mm.; hind tibiae .40 to .50 mm.; hind tarsi .10 mm.; antennae .85 to .95 mm.; III .17 to .25 mm.; IV .11 to .15 mm.; V .11 to .15 mm.; VI .10 + .15 to .20 mm.; cornicles .20 to .34 mm.; cauda .03 mm. hard portion, .08 entire length; rostrum acute, joint IV + V tapering, .15 mm. long, tip beyond hairs slender and needle-like, resembling distinct 5th.

joint, attaining 1st. abdominal segment. Alate vivipara.—Same as aptera except cornicles .10 to .17 mm., hind tibiae .50 to .60 mm.; rostrum attaining 3d. coxae.

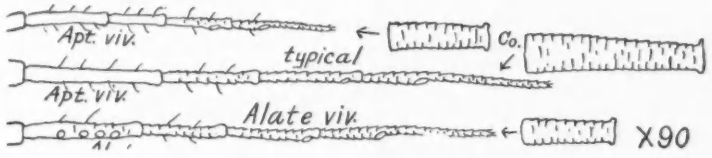


FIG. 129. *Aphis hermistonii.*

Structural Characters.—Secondary sensoria round, flat and arranged in a single row along most of III, 4 to 5 in number, 0 on IV in alatae; absent in apterae. Hairs pointed, fine, erect, .03 mm. on vertex, antennae and outer side of hind tibiae. Cornicles cylindrical, with flange, imbricated. Cauda conical, short, and blunt, shorter than hind tarsi, bearing 3 curved hairs on each side. Lateral tubercles developed on prothorax and 1st. and 7th. abdominal segments.

Collections.—On leaves and tender twigs of *Artemisia tridentata* and *filifolia* at Eckert, Craig, Steamboat Springs, and Cherokee Park; apterous summer viviparae June 17 to Aug. 30, alate viviparae Aug. 8; 4 collections, not abundant.

Taxonomy.—See discussion under *Aphis canae* Williams in this paper or Gillette and Palmer (1928 loc. cit.). The examples above described were determined by comparison with cotype slide No. 451 from collection of H. F. Wilson, kindly loaned to us by A. A. Granovsky.

Aphis incognita Hottes and Frison.

Hottes and Frison, Ill. Nat. Hist. Surv. Bul., Vol. 19, p. 438, 1930.

For description see Oestlund, Geol. and Nat. Hist. Surv. Minn., Bul. 4, p. 50, 1887. *Aphis symphoricarpi* Thos.

Color.—Viviparae.—Yellowish-green, with dark lateral spots and dark bands on posterior abdominal segments in alatae and on all seg-

FIG. 130. *Aphis incognita.*

ments and head in fundatrices; legs dusky; cornicles dusky, yellowish at base in apterae and surrounded by yellowish area; wing veins blackish and bordered with brownish.

Measurements.—Apterous summer vivipara.—Body to base of cauda 2 to 3 mm. by 1.4 to 1.6 mm.; hind tibiae 1 mm.; hind tarsi .14 mm.; antennae 1.4 to 1.5 mm.; III .33 to .35 mm.; IV .25 to .27 mm.; V .24 mm.; VI .12 + .38 to .47 mm.; cornicles .30 mm.; cauda .04 to .05 mm. Alate vivipara.—Body to base of cauda 1.66 mm.; hind tibiae 1.9 mm.; antennae 1.3 to 1.5 mm.; III .30 to .39 mm.; IV .23 to .34 mm.; V .18 to .25 mm.; VI .10 + .40 to .52 mm.; cornicles .20 to .30 mm.; cauda .04 mm. hard portion, .09 mm. entire length; rostrum obtuse, joint IV + V .13 to .14 mm. long, attaining between 2d. and 3d. coxae.

Structural Characters.—Antennal joints heavy, wider than hind tibiae. Secondary sensoria very tuberculate, with wide margins and crowded so that some are transversely oval instead of circular, scattered over entire length of joints in both alatae and apterae, about 28 on III, 18 on IV, and 10 on V; smaller and less tuberculate in apterae; in fundatrices present on III only, about 15 in number, III and IV often coalesced. Hairs on antennae and vertex pointed .015 mm. long, sparse; on outer side of hind tibiae .02 to .03 mm. Cornicles cylindrical, with flange imbricated. Cauda short, hardly evident, broader than long, conical with obtuse tip which is usually upturned, bearing numerous fine, curved hairs. Mediae of fore wings with 2d. fork .5 or more of distance from margin of wing to 1st. fork. Lateral tubercles very broad and shallow.* Sexuales not known.

Collections.—On leaves of *Symphoricarpos occidentalis*, during summer, on roots in spring (fundatrices) near Fort Collins, Bellvue, and Cedaredge; fundatrices May 31, apterous summer viviparae May 28 to June 16, alate viviparae May 28 to July 8; 6 collections, rare; usually found associated with *Brevicoryne symphoricarpi* (Thos.).

Taxonomy.—The genus *Cedoaphis* was erected by Oestlund for this species on account of the peculiar lateral tubercles. Tubercles of this appearance, however, are also found in occasional species of widely separated genera, and accordingly do not seem to represent a generic complex. Takahashi (Pr. Ent. Soc. Wash., Vol. 32, p. 9, 1930) has placed *Cedoaphis* as a synonym of *Anuraphis*.

Aphis laciniariae Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Am., Vol. 22, p. 15, 1929.

Measurements.—Apterous summer vivipara.—Body to base of cauda 1.4 mm.; hind tibiae .4 to .5 mm.; hind tarsi .10 mm.; antennae .75 mm.; III .12 to .18 mm.; IV .10 to .13 mm.; V .09 to .12 mm.; VI .08 + .14 to .20 mm.; cornicles .12 to .19 mm.; cauda .11 mm. entire length .08 mm. on median line of hard portion; rostrum obtuse, joint

*These structures are considered glands of the same order as the cornicles by Oestlund (19th. Rept. of State Ent. of Minn., p. 127, 1922).

IV + V .10 mm. long, by .04 mm. at base, attaining 3d. coxae or abdomen. Alate vivipara.—Same as aptera except cornicles .11 to .15 mm.; cauda .10 mm. entire length, .06 to .07 mm. on median line of hard portion; rostrum attaining between 2d. and 3d. coxae.

Structural Characters.—Secondary sensoria round, irregular in size, scattered over most of joint III in alate viviparae 4 to 8 in number; on IV, 0 or rarely 1 or 2; absent in apterae. Cornicles cylindrical, sometimes slightly broader at base in apterae, imbricated and without flanges. Cauda rather elongated, conical and acute, bearing about 3 hairs on each side. Lateral tubercles broad and blunt, present on prothorax and abdominal segments 1 to 6. Hairs pointed, minute,

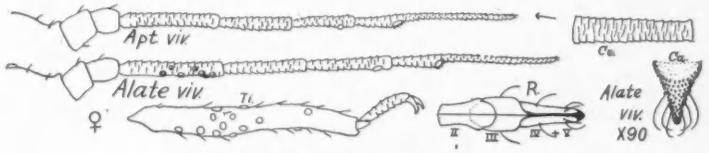


FIG. 131. *Aphis laciniariae.*

.01 mm. long and very sparse, on antennae, body and outer side of tibiae; on cauda .05 mm. long and curved. Fore wings with 2d. fork of media .33 to .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae slightly swollen with about 10 rather large, slightly convex sensoria scattered along almost entire length of tibiae.

Collections.—On leaves and stems of *Laciniaria punctata* near Fort Collins and Boulder; apterous summer viviparae July 5 to Sept. 7, alate viviparae July 5 to Aug. 28, oviparae Sept. 13 to Oct. 5; 9 collections, not common.

Types in U. S. Nat. Mus., Cat. No. 41459; paratypes in collection of Colo. Agr. Exp. Sta.

Aphis lugentis Williams.

Williams, "Aph. Neb." Univ. Studies, Vol. 10, p. 46, 1910.

Color.—Viviparae.—Dark olive or blackish-green, often marked with dusky, in alatae especially, on bands on dorsum of posterior abdominal segments and lateral areas of all abdominal segments; legs, cornicles and antennae dusky to black throughout; pupae of male orange.

Measurements.—Apterous summer vivipara.—Body to base of cauda 2 to 2.8 mm.; hind tibiae .9 to 1 mm.; hind tarsi .13 mm.; antennae 1.1 to 1.25 mm.; III .30 to .43 mm.; IV .20 to .30 mm.; V .16 to .21 mm.; VI .12 + .18 to .24 mm.; cornicles .21 to .28 mm.; cauda .10 mm. on median line of hard portion, .16 to .18 mm. entire length; rostrum obtuse, joint IV + V .13 to .15 mm. long, attaining between 2d. and 3d. coxae. Alate vivipara.—Same as aptera except cornicles .19 to .22 mm.; cauda .08 mm. on median line of hard portion, .14 mm. entire length.

Structural Characters.—Secondary sensoria round, medium in size, scattered along entire length of joints, 19 to 24 on III, 7 to 11 on IV and 0 to 3 on V in alate viviparae; in apterous viviparae 1 to 11 distally on III, 7 to 11 on IV and 0 to 2 on V; in oviparae 0 on III, 2 to 4 on IV, 0 on V, antennal joints shorter than in viviparae. Hairs pointed, .02 to .04 mm. long, shorter than diameter of antennal joints. Cornicles cylindrical, with flanges and imbricated. Cauda elongated, nearly parallel-sided, blunt and with tendency to constriction near base, bearing 6 or 7 hairs on either side. Lateral tubercles present. Mediae of fore wings with 2d. fork .33 to .5 the distance from margin of wing to

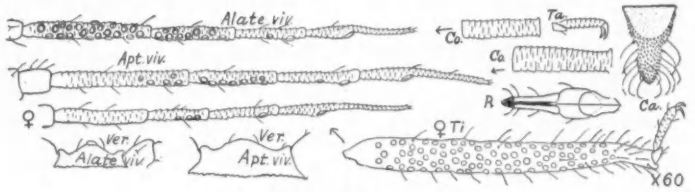


FIG. 132. *Aphis lugentis.*

1st. fork. Oviparae with hind tibiae distinctly swollen and thickly covered along almost entire length with moderately large, round, flat sensoria. Males usually alate but occasionally apterous, with sensoria on III, IV and V usually somewhat more numerous than in alate viviparae.

Collections.—On leaves, stems and roots of *Senecio atratus, scopulinum, spartioides* and *triangularis* generally throughout the state; apterous summer viviparae May 26 to Oct. 22, alate viviparae June 12 to Oct. 13, oviparae Oct. 10 to 22, males Oct. 4 to 22; 34 collections, common.

Taxonomy.—The determination of this species was made by comparison with cotype specimens kindly loaned by Myron H. Swenk of the University of Nebraska. Our apterae agree with Williams' apterae. His alatae belong to another species. The species name is held by the apterous form, its description preceding that of the alate form.

Aphis lupini Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Am., Vol. 22, p. 18, 1929.

Color.—Dusky-olive to blackish-green, shading to brown or black on head; legs pale or dusky; cornicles and cauda dark; veins of fore wings rather heavy; stigmae dusky-yellowish.

Measurements.—Apterous summer vivipara.—Body to base of cauda 2 to 3 mm. by 1.1 to 1.8 mm.; hind tibiae 1.10 mm.; hind tarsi .15 mm.; antennae 1.5 mm.; III .36 to .40 mm.; IV .25 to .33 mm.; V .25 mm.; VI .14 + .20 to .28 mm.; cornicles .22 to .30 mm.; cauda

entire length .28 mm., hard portion .17 mm.; rostrum obtuse, joint IV + V rather slender, .17 mm. long, attaining between 2d. and 3d. coxae. Alate vivipara.—Same as aptera or slightly smaller.

Structural Characters.—Secondary sensoria round, flat, arranged in a row on joint III, 3 to 6 in number, absent on remaining joints of alatae; 0 to 4 on III in apterous viviparae. Hairs pointed, .03 to .04 mm. long, rather sparse on body; moderately numerous and semi-erect on antennae and legs, nearly as long as diameter of joint bearing them. Cornicles

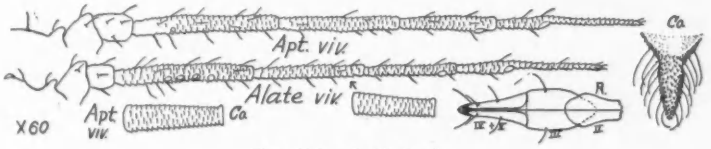


FIG. 133. *Aphis lupini.*

cylindrical or slightly tapering, closely imbricated, with inconspicuous flanges. Cauda elongate-conical, acute with but little neck, bearing 8 to 10 pairs of lateral hairs. Fore wings with 2d. fork of media .33 to .5 the distance from margin of wing to 1st. fork. Lateral tubercles small but present on prothorax and all abdominal segments. Sexuales not known.

Collections.—On leaves and stems of *Lupinus decumbens* at Fort Collins, Boulder and Stove Prairie (above Bellvue); fundatrices May 22, apterous summer viviparae May 13 to Aug. 31, alate viviparae May 15 to July 6; 13 collections, common.

Types in U. S. Nat. Mus., Cat. No. 41462; paratypes in collection of Colo. Agr. Exp. Sta.

Aphis lutescens Monell.

Monell, Bul. U. S. Geol. and Geog. Surv. Terr., Vol. 5, p. 23, 1879.

Color.—Viviparae.—Bright lemon-yellow; lateral areas on abdominal segments and blotches at bases of cornicles dusky in alatae; cauda and cornicles black; legs and antennae yellowish to dusky.

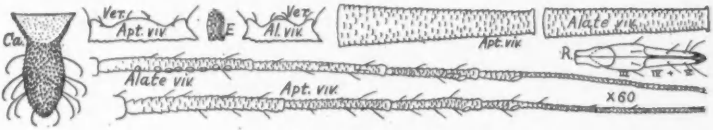


FIG. 134. *Aphis lutescens.*

Measurements.—Apterous vivipara.—Body 2.2 to 3 mm.; hind tibiae 1.10 to 1.50 mm.; hind tarsi .12 to .14 mm.; antennae 1.50 to

1.63 mm.; III .35 to .45 mm.; IV .28 to .38 mm.; V .22 to .25 mm.; VI .10 + .35 to .50 mm.; cornicles .40 to .60 mm.; cauda .28 mm. entire length, .20 mm. hard portion; rostrum obtuse, joint IV + V .16 to .17 mm. long, attaining between 2d. and 3d. coxae. Alate vivipara.—Same as aptera except cornicles .35 to .45 mm.

Structural Characters.—Secondary sensoria rather large, circular, not tuberculate, arranged in single row along entire length of joint III, 5 to 10 in number in alate viviparae;* absent in apterae. Hairs pointed, drooping, about .02 mm. long. Cornicles cylindrical or slightly tapering, with flange and covered with close and short imbrications. Cauda elongated, blunt, with slight neck, and bearing 3 pairs of lateral, 2 pairs of dorsolateral and one median apical hairs. Rostrum obtuse, attaining between 2d. and 3d. coxae. Lateral tubercles present on prothorax, and first and seventh abdominal segments, feebly developed. Media of fore wings with 2d. fork over .33 the distance from margin of wing to 1st. fork.

Collections.—On leaves and stems of *Asclepias galioides* and sp. at Fort Collins, Paonia, Rocky Ford, Fruita, Delta and Grand Junction; apterous summer viviparae Aug. 12 to Oct. 14, alate viviparae Sept. 6 to Oct. 14, sexuales not taken; 10 collections, in crowded colonies, fairly common.

Taxonomy.—This species has been considered by the aphidologists of the United States as *nerii* of Boyer, (Ann. Soc. Ent. Fr., Vol. 10, p. 179, 1841) instead of *lutescens* Monell, due to the fact that Monell mentioned no black patches at the bases of the cornicles. The first authorities giving this determination, not having access to Boyer's description did not know that he also mentions no black patches at bases of cornicles. Indeed, Boyer's description refers only to color and the species is declared unrecognizable by Kaltenbach (Ent. Seit., Vol. 6, p. 18, 1845). Shouteden (Aph. de Belg. p. 232, 1906) lists *nerii* Boyer under the genus *Myzus* and places *asclepiadis* Passerini as a synonym. If Boyer's species is really a *Myzus*, then of course the American species under discussion certainly is not Boyer's species. The writers prefer to use the American name.

Aphis maculatae Oestlund.

Oestlund, Aph. Minn., Geol. and Nat. Hist. Surv. Minn., p. 61, 1887.

Color.—All forms.—Brownish-black with conspicuous patches of white powder.

*One collection of 10 alate viviparae was taken on *Asclepias* sp. which show 12 to 14 sensoria on III and 2 to 8 on IV, but in other characters seem inseparable from the species here described.

Measurements. — Apterous vivipara. — Body to base of cauda 2.76 mm.; hind tibiae 1.6 mm.; antennae 2 mm.; III .60 to .70 mm.; IV .33 to .36 mm.; V .25 to .30 mm.; VI .13 + .39 to .41 mm.; cornicles .70 to .80 mm.; cauda .20 mm. Alate vivipara.—Body to base of cauda 1.77 mm.; hind tibiae 1.1 mm.; antennae 1.66 mm.; III .58 mm.; IV .34 mm.; V .27 mm.; VI .12 + .42 mm.; cornicles .46 mm.; cauda .15 mm.; rostrum obtuse, joint IV + V .15 mm., attaining between 2d. and 3d. pair of coxae.*

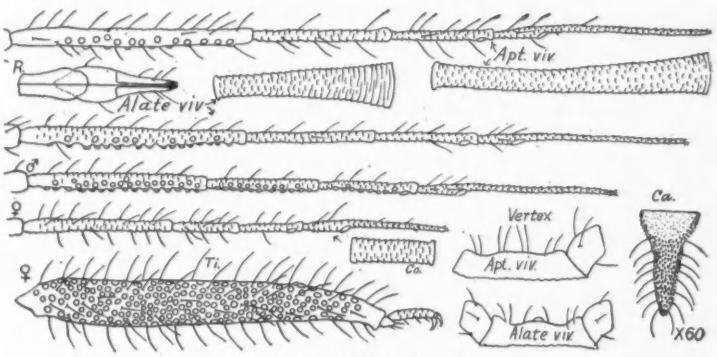


FIG. 135. *Aphis maculatae.*

Structural Characters.—Secondary sensoria in irregular double row along entire joint III, about 25 in alate viviparae; 15 to 22 in apterous viviparae; none in oviparae; numerous on III, IV and V in males. Hairs nearly erect, numerous, .04 to .06 mm. long on vertex, antennae and outer side of tibiae. Cornicles cylindrical, slightly tapering, finely imbricated. Cauda slender cylindrical with slight neck and bearing 8 to 10 pairs of hairs. Lateral tubercles developed. Mediae of fore wings with 2d. fork .33 to .5 the distance from margin of wing to 1st. fork. Males alate. Oviparae with hind tibiae conspicuously swollen for entire length and bearing numerous sensoria.

Collections.—On twigs and leaves of *Populus balsamifera* and *Svida stolonifera* at Fort Collins, Estes Park, Delta and Meeker; apterous summer viviparae June 26 to Sept. 8, alate viviparae June 26 to Aug. 30, oviparae Sept. 8 to 28, males Aug. 24 to Sept. 10; 10 viviparae all taken on *Populus*, oviparae on *Svida;* 15 collections, rare, but in large numbers when found.

*These measurements seem considerably longer than those in the original description, but agree with specimens received from Minnesota, collected by F. C. Hottes and compared with types in co-operation with Dr. Oestlund.

Aphis maidi-radicis Forbes.

Forbes, Seventeenth Rep. Nox. & Ben. Ins. Ill., p. 64, 1891; also 18th. Rept., pp. 58–69, 1894.

For fuller description see Davis, U. S. D. A., B. E., Tech. Series No. 12, Pt. 8, p. 123–137, 1909.

Color.—Viviparae.—Pale green with more or less dusky markings on head pronotum, lateral areas and dorsal bands especially on terminal segments of abdomen.

Measurements.—Apterous viviparae.—Body 1.80 mm.; hind tibiae .80 mm.; hind tarsi .10 mm.; antennae .70 mm.; III .17 to .22 mm.; IV .08 to .10 mm.; V .08 to .10 mm.; VI .08 to .10 + .16 to .19 mm.; cornicles .08 to .13 mm.; cauda .04 to .05 mm. on hard portion; rostrum obtuse, joint IV + V .13 mm. long, attaining 3d. coxae or abdomen. Alate vivipara.*—Body 1.50 mm.; hind tibiae .70 mm.; hind tarsi

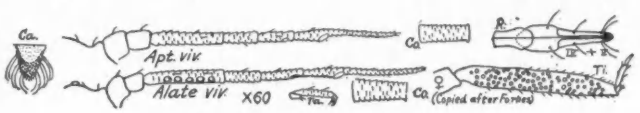


FIG. 136. *Aphis maidi-radicis.*

.10 mm.; antennae .70 mm.; III .20 to .24 mm.; IV .09 to .10 mm.; V .08 to .10 mm.; VI .09 to .11 + .18 to .20 mm.; cornicles .12 to .14 mm.; cauda .05 mm.; rostrum attaining between 2d. and 3d. coxae.

Structural Characters.—Secondary sensoria round, hardly tuberculate, in single row, 4 to 7 in number along most of joint III, usually 0 but sometimes 1 to 3 on distal portion of IV, none on V in alate viviparae; usually none in apterae, rarely 1 to 3 on III, 0 or rarely 1 on IV and V. Cornicles cylindrical, hardly expanded at base, imbricated and with weak flange. Cauda bluntly conical and bearing about 6 hairs on each side. Hairs pointed, inconspicuous, drooping and sparse, .01 to .02 mm. long on antennae, body and tibiae; on cauda .04 to .05 mm. and curved. Mediae of fore wings with 2d. fork .33 to .5 the distance from margin of wing to 1st. fork. Lateral tubercles developed on prothorax, and 1st. and 7th. abdominal segments, inconspicuous or absent on other segments. Males apterous (Davis, 1909, cited above), (Weed, Am. Nat., Vol. 22, p. 70, 1888, and Bull. Ill. St. Lab. Nat. Hist., Vol. 3, Art. 12, 1897), (Forbes, Eighteenth Rept. of St. Ent., of Ill., p. 63, 1894), alate (Vickery, U. S. D. A., B. E., Bul. 85, p. 113, 1910)†. Oviparae with hind tibiae strongly swollen on entire length and thickly covered with numerous small sensoria.

Collections.—On roots of *Artemisia frigida*, *Aster* sp., *Taraxacum officinale* and *Zea Mays* at Fort Collins, Julesburg and

*From collection by Geo. G. Ainslie, from roots of corn in Marion, S. C., May 31, 1909, and from two examples taken in Fort Collins, Colo.

†Vickery reared three alate males on corn from stock taken from *Ambrosia artemisiaefolia* and *Leptochloa filiformis*. These might possibly be *A. middletonii* in which species the males are alate.

Denver; apterous viviparae June 8 and Aug. 11, alate viviparae Aug. 20; 3 collections, only one of these at Julesburg in extreme northeast corner of state, reported as causing serious damage, evidently rather rare.*

Taxonomy.—This species appears structurally very close and doubtfully separable from *A. middletonii;* perhaps it should be placed as a variety. Considerations against placing it as a synonym are: first, structural differences, namely, the scarcity of sensoria, shortness of antennal joints and cornicles and smaller body, besides the apterous condition of males in the collections observed from corn roots, cucurbits and *Chenopodium*, (16 collections from outside the state were studied besides the 3 Colorado collections); second, the almost total absence of corn root trouble from this aphis in Colorado and other western states, in spite of the abundance of *A. middletonii* on other plants throughout these states (See Essig, Ins. Western N. Amer., p. 236, 1926), third; lack of collections in the state on cucurbits and grasses, which *maidi-radicis* has been recorded as readily infesting. These observations corroborate the results by R. A. Vickery published in 1910.† It accordingly seems best to the writers to consider these two forms as closely related species until further study proves otherwise.

Aphis maidis Fitch.

Fitch, Second Rept. Nox. & Ben. Insects N. Y., p. 318, 1856.

Color. — Viviparae. — Pale bluish-green, darker on area about cornicles, brownish anteriorly, darkest on head, (old adult apterae darkest), covered with powder, alatae with dusky lateral areas on abdominal segments anterior to cornicles, and dorsal dashes posterior to cornicles; antennae, cornicles, cauda and legs dusky.

Measurements.—Apterous summer vivipara.—Body 2 to 2.5 mm., rather elongate; hind tibiae .75 mm.; hind tarsi .12 mm.; antennae .80 to 1 mm.; III .21 to .29 mm.; IV .11 to .15 mm.; V .09 to .14 mm.;

*Statement by Gillette (Jo. Ec. Ent., Vol. 3, p. 405, 1910) that this species is fairly common on corn at Fort Collins evidently refers, at least in part, to *A. middletonii*, as shown by the drawings and hosts given as well as slides of those dates in the collection. No serious corn root-aphis injury has attracted attention at Fort Collins.

†However, it seems that the comparison of sizes of the two species as given by Vickery must be reversed, (being presumably a typographical error) judging from published measurements of other workers and our own observations, including study of slides of thirty examples from corn roots, taken at Marion, S. C., by Geo. G. Ainslie, evidently from the very same experiments reported in the bulletin above mentioned.

VI .11 + .17 to .26 mm.; cornicles .13 to .19 mm.* Alate vivipara.—Body 2 to 2.5 mm.; hind tibiae .80 mm.; hind tarsi .12 mm.; antennae 1 mm.; III .24 to .32 mm.; IV .14 to .18 mm.; V .12 to .17 mm.; VI .10 + .15 to .23 mm.; cornicles .13 to .15 mm.; cauda entire length .11 mm., hard portion .07 mm.; rostrum obtuse, joint IV + V broad, .09 mm. long by .05 mm. at base, hardly attaining 2d. coxae.

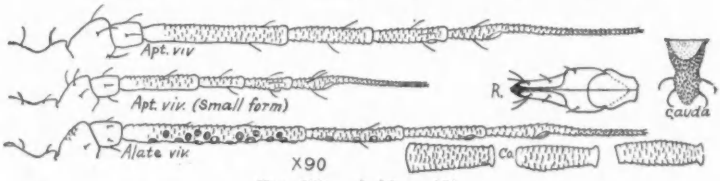


FIG. 137. *Aphis maidis.*

Structural Characters.—Secondary sensoria round, scattered along entire length of joints, 14 to 18 on III, 0 to 8 on IV, 0 to 3 on V in alate viviparae; absent in apterae. Cornicles slightly incrassate, with slight constriction next to flange, imbrications slightly serrate. Cauda approximately cylindrical with rounded tip and distinct but broad neck and bearing 2 or 3 hairs on each side. Hairs pointed, .02 to .03 mm. long, drooping and sparse on all parts. Lateral tubercles present but small. Mediae of fore wings with 2d. fork .2 to .33 the distance from margin of wing to 1st. fork.

Collections.—On leaves and stems of (corn) *Zea Mays, Sorghum vulgare* and the following grasses: *Panicum crus-galli, Panicum capillare, Setaria viridis, Avena sativa, Hordeum sativum* at Denver, and Fort Collins; apterous summer viviparae March 21 to Nov. 19, alate viviparae March 21 to Nov. 19; 32 collections, fairly common.

Taxonomy.—This species is distinguished from *Aphis pruni-foliae* by the more bluish color, less swollen cornicles, broader cauda and shorter measurements of antennal joints and cornicles.

Aphis medicaginis Koch.

Koch. Die Pflanzenlause Aphiden, p. 94, 1854.

Color.—Viviparae.—Black on entire dorsum, polished in adults, dull and pulverulent with slaty-grayish tint in nymphs, pale grayish-green in new born young; cornicles and cauda black; legs and antennae whitish.

Measurements.—Apterous vivipara.—Body 1.6 to 1.9 mm.; by 1 to 1.1 mm., broadly ovate; hind tibiae .90 mm.; hind tarsi .12 mm.; antennae 1.1 mm.; III, .25 to .31 mm.; IV .20 to .26 mm.; V .18 to .27 mm.; VI .10 to .13 + .17 to .26 mm.; cornicles .26 to .35 mm.;

*Small individuals, evidently mature, occur with measurements hardly exceeding half those given above.

cauda .16 mm. entire length, .12 mm. hard portion; rostrum obtuse, joint IV + V .11 mm. long, attaining about to 3d. coxae. Alate vivipara.—Same as aptera except cornicles usually .20 to .28 mm.

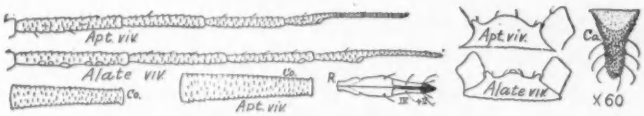


FIG. 138. *Aphis medicaginis.*

Structural Characters.—Secondary sensoria round, arranged in single row, 4 to 7 on III in alatae, absent on all other joints and in apterae. Hairs pointed, drooping, sparse; on antennae about .01 to .02 mm. long; on tibiae .03 mm. Lateral tubercles prominent on pronotum and abdominal segments 1, 2 and 7, usually present but smaller on intervening segments. Cornicles cylindrical or slightly tapering, with slight flange, finely imbricated. Cauda blunt, rather cylindrical with broadened base, bearing 3 pairs of lateral hairs and a single median one. Mediae of fore wings with 2d. fork half way between first fork and margin of wing. Sexuales unknown.

Collections.—On leaves and stems of *Amaranthus* sp., *Aragallus* sp.; *Astragalus* sp.; *Capsella bursa-pastoris; Chenopodium album, Cleome serrulata, Gaura cocinea, Glycerrhiza lepidota, Iva axiliaris, Kochia scoparia, Lactuca* sp., *Lepidium* sp., *Malva* sp., *Medicago sativa, Melilotus alba* and *officinalis, Phaseolus lunatus* and *vulgare, Polygonum* sp., *Pyrus communis* and *malus, Robinia* sp., *Rumex* sp., *Salsola pestifer, Solidago* sp., *Sophia* sp., *Taraxacum officinale, Trifolium pratense, Triticum vulgare, Vicia* sp., and *Vigna sinensis* generally throughout the state; apterous summer viviparae March 25 to Nov. 10, alate viviparae April 3 to Nov. 19; nearly 100 collections, very common.

Aphis menthae-radicis Cowen.

Gillette and Baker, "Hemip. of Colo." Agr. Exp. Sta., Bul. 31, Tech. Series 1, p. 121, 1895.

Color.—Viviparae.—Green; head, thorax, lateral areas and dorsal dashes on abdomen black, especially marked in the apterae; apparently a dull lead color unmagnified; appendages mostly black.

Measurements.—Apterous summer vivipara.—Body 1.8 to 2 mm.; hind tibiae .73 to .80 mm.; hind tarsi .14 mm.; antennae .75 mm.; III .23 to .27 mm.; IV .13 mm.; V .10 mm.; VI .09 + .18 mm.; cornicles .13 to .16 mm.; cauda entire length .13 mm., hard portion .07 mm. Alate vivipara.—Body 2 mm.; hind tibiae .95 mm.; hind tarsi .14 mm.; antennae 1.03 mm.; III .25 to .30 mm.; IV .14 to .17 mm.; V .13 to

.14 mm.; VI .10 + .20 to .25 mm.; cornicles .15 to .18 mm.; cauda entire length .13 mm., hard portion .07 mm.; rostrum obtuse, joint IV + V slender .13 to .15 mm.; attaining between 2d. and 3d. coxae.

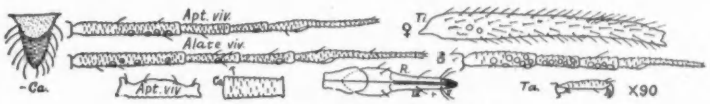


FIG. 139. *Aphis menthae-radicis.*

Structural Characters.—Secondary sensoria round, unequal in size, arranged in irregular single row along distal .66 of joint, 4 to 8 on III, 1 to 2 on IV, 0 to 1 on V in alatae; in apterae 2 to 7 on III, 0 to 2 on IV, 0 to 3 on V. Cornicles cylindrical or slightly tapering, with flange and imbricated. Cauda short, conical, bearing 6 to 8 hairs on each side and one median one at tip. Hairs pointed, drooping; .02 to .03 mm. long on antennae and vertex; .05 mm. long and curved on cauda. Lateral tubercles present. Fore wings with 2d. fork of media over .33 to barely .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae pale, slightly swollen on proximal .33 and bearing a few scattered faint sensoria. Males apterous. (Data for description of viviparae taken from original description and from examination of type specimens in collections.)

Collections.—On roots of *Mentha canadensis, Artemisia aromatica, Taraxacum officiniale* and *Aster* sp. at Hotchkiss and Fort Collins; apterous summer viviparae July 14 to Nov. 5, alate viviparae July 14, sexuales Nov. 5; 2 collections of about 30 examples in all, on *Mentha*, on the other hosts 3 collections, not common.

Taxonomy.—This species is very close to *A. middletonii* Thos. and *A. maidi-radicis* Forbes. It was stated to be a synonym of the latter species by Vickery (U. S. D. A., B. E., Bul. 85, 1910) acting on the opinion of Gillette on comparing viviparae. Gillette (Vickery 1910, loc. cit.) stated that there were slight differences but doubted their being sufficient to separate the species. Later a study of sexuales shows the hind tibiae of the oviparae of this species to be less swollen and bearing a much smaller number of sensoria. This character and the longer antennal joints and cornicles constitute the distinguishing characters.

Aphis middletonii Thomas.

Thomas, Eighth Rep. St. Ent. Ill., p. 99, 1879.

Color.—Viviparae.—Green, yellowish to dusky-olive; with powdery reticulations; dusky on dorsum of head and pronotum, lateral areas of

all segments anterior to cornicles, bands on all segments but more or less broken or lacking on abdomen anterior to cornicles especially in alatae; legs and antennae brownish or dusky; cornicles and cauda dusky.

Measurements.—Apterous vivipara.—Body 1.5 to 2.5 mm.; hind tibiae .60 to .95 mm.; hind tarsi .13 mm.; antennae .80 to 1.1 mm.; III .23 to .32 mm.; IV .14 to .18 mm.; V .14 to .17 mm.; VI .09 to .12 + .16 to .21 mm.; cornicles .13 to .20 mm.; cauda .07 mm. hard portion on median line; rostrum obtuse, joint IV + V .15 mm. long, hardly attaining 3d. coxae. Alate vivipara.—Body 1.9 to 2 mm.; hind tibiae .8 to 1 mm.; hind tarsi .11 to .14 mm.; antennae 1 mm.; III .25 to .32 mm.; IV .14 to .17 mm.; V .13 to .19 mm.; VI .12 + .19 to .28 mm.; cornicles .13 to .17 mm.; cauda .06 to .07 mm. on median line of hard portion.

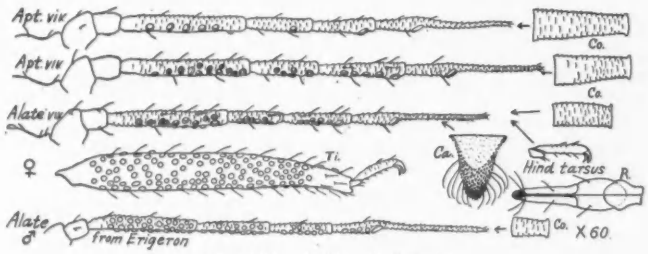


FIG. 140. *Aphis middletonii.*

Structural Characters.—Secondary sensoria round, but slightly tuberculate, arranged in more or less irregular double row, 10 to 16 in number, along most of III, 2 to 9, on distal .5 or .66 of IV, 0 to 6 on V in alate viviparae; apterous viviparae with 5 to 12 on distal .5 or .75 of III, 1 to 6 on IV; 0 to 5 on V. Hairs pointed, inconspicuous, shorter than diameter of antennae, drooping and sparse. Cornicles cylindrical or slightly broader at base, imbricated, and with weak flange. Cauda bluntly conical, bearing about 5 to 7 hairs on each side. Fore wings with 2d. fork of media about .5 the distance from margin of wing to 1st. fork. Lateral tubercles quite large on prothorax, and 1st. and 7th. abdominal segments, inconspicuous or absent on other segments. Oviparae with hind tibiae dusky, swollen along entire length and bearing numerous slightly convex sensoria. Males alate.

Collections.—On roots of *Acerates angustifolia*, *Ambrosia trifida*, *Radicula armoracia*, *Artemisia frigida*, *Aster multiflorus*, *Capsella bursa-pastoris*, *Erigeron canadensis*, *Helianthus pumilus*, and sp., *Rumex acetosella* and sp., *Taraxacum officinale*, *Senecio scopulinus*, *Sophia* sp. and *Zea Mays* at Fort Collins, Boulder, Manassa, Antonito, Hotchkiss, Denver, Cheyenne Canon, Manitou, Ridgway, Longmont and Salida; fundatrices May 21

and 28, apterous summer viviparae May 8 to Oct. 8, alate viviparae May 31 to Oct. 8, oviparae Sept. 27 to Nov. 6, males Sept. 27 to Oct. 7; 80 collections, very common.

Taxonomy.—The Colorado examples as a rule run higher in measurements and numbers of sensoria than the records by other observers; it might seem that perhaps *A. armoraciae* Cowen should be retained for these if it were not for the finding of a minority of specimens with shorter measurements showing such gradual intergrading that no line of separation can be drawn. Though the range of variation is very large *Aphis armoraciae* Cowen is here placed as a synonym.

Aphis minutissima Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Am., Vol. 21, p. 8, 1928.

Color.—All forms.—Dark brown to black; marked with powdery reticulations.

Measurements.—Apterous vivipara.—Body .95 to 1.25 mm.; hind tibiae .30 to .40 mm.; antennae .40 to .50 mm.; III .08 to .13 mm.; IV .06 to .08 mm.; V .08 mm.; VI .07 + .04 to .06 mm.; cornicles .035 mm.; cauda .04 mm. on median line of hard portion; tarsi .09 mm.

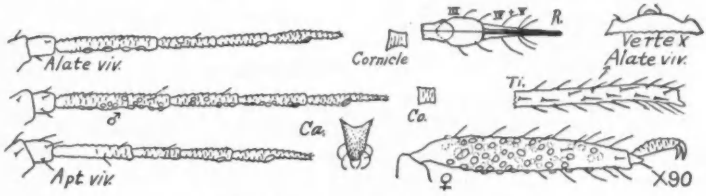


FIG. 141. *Aphis minutissima.*

Rostrum acute, attaining 1st. segment of abdomen, joint IV + V laterally compressed, very slender and .14 mm. long, tip .07 mm. long and parallel-sided, resembling, in ventral aspect, distinct fifth joint. Alate vivipara.—Body 1.30 mm.; hind tibiae .50 mm.; antennae .54 to .60 mm.; III .14 to .20 mm.; IV .09 to .11 mm.; V .09 to .10 mm.; VI .07 to .09 + .06 mm.; cornicles, cauda, and tarsi as in aptera.

Structural Characters.—Secondary sensoria circular, large, arranged in a single row on distal .75 of joint III, 2 to 5 in number in alate viviparae. Hairs pointed; sparse and .01 mm. long on antennae; on vertex .03 mm., in alatae, .04 to .05 mm. in apterae; on hind tibiae .03 mm., rather numerous; on cauda .07 mm., curved and rather heavy. Cornicles cylindrical to truncate, imbricated, with hardly perceptible flange. Cauda obtusely conical to parallel-sided, rounded at tip, slightly longer than wide, bearing 2 curved hairs on either side and one dorsal pair. Lateral tubercles evident on prothorax and 1st. and 7th.

abdominal segments. Mediae of fore wings with 2d. fork about .5 the distance from margin of wing to 1st. fork. Males alatae. Hind tibiae of oviparae much swollen and thickly covered throughout with large sensoria.

Collections.—On leaves and stems of *Artemisia filifolia* at Denver; apterous summer viviparae July 10 to Oct. 8, alate viviparae July 10 and Aug. 14, sexuales Oct. 8; 6 large collections.

Types in U. S. Nat. Mus., Cat. No. 41973; paratypes in collection of Colo. Agr. Exp. Sta.

Aphis monardae Oestlund.

Oestlund, Geol. and Nat. Hist. Surv. Minn., Bul. **4**, p. 58, 1887.

Color.—Alate vivipara.—"Abdomen greenish, with much mottling of black above. Honey tubes black." (Oestlund, 1887).* Balsam specimens showing legs mostly pale, antennae and cornicles dusky.

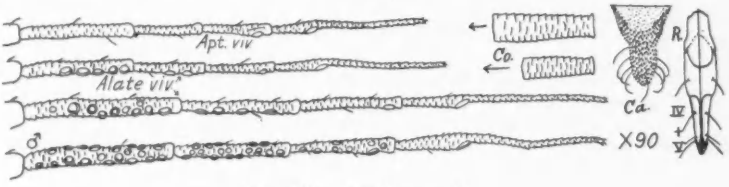


FIG. 142. *Aphis monardae.*

Measurements.—Apterous summer vivipara.—Body 1.2 to 1.5 mm. by 1 mm.; hind tibiae .70 mm.; hind tarsi .10 mm.; antennae 1.1 mm.; III .20 to .30 mm.; IV .20 to .22 mm.; V .16 to .20 mm.; VI .10 + .20 to .25 mm.; cornicles .12 to .22 mm.; cauda entire length .11 to .15 mm., hard portion .08 to .11 mm.; rostrum obtuse, joint IV + V rather slender, .09 or .10 mm. long, attaining second coxae. Alate vivipara.—Same as aptera.

Structural Characters.—Secondary sensoria round, large; on III, 5 to 7 in single row, sometimes 8 to 12 smaller ones in irregular double row, apparently resulting from dividing of normal sensoria; on IV, 2 to 4; absent in apterae. Hairs inconspicuous, sparse, drooping; on antennae .01 mm. long; on outer side of tibiae .02 mm. Cornicles cylindrical, with slight flange and imbricated. Cauda obtuse, approximately cylindrical, with slightly broader base bearing 3 or 4 pairs of lateral and one median hair. Lateral tubercles well developed on prothorax, and abdominal segments 1 and 6. Mediae of fore wings with 2d. fork from hardly .25 to over .33 the distance from margin of wing to 1st. fork. Males alate.

*Color of Colorado specimens not described before mounting.

Collections.—On leaves and flower heads of *Monarda* sp. in foothills near Boulder and Fort Collins and in canon of Big Thompson River; apterous summer viviparae June 6 to Aug. 2, alate viviparae May 30 to Aug. 2, males Nov. 10. Neither fundatrices nor oviparae have been taken and alatae were taken earlier than apterae; perhaps an alternate host exists; 9 collections, fairly common.

Taxonomy.—This species is near *A. oestlundi* Gillette but is distinguished by cornicles usually being shorter and secondary sensoria usually more numerous on III and present on IV.

Aphis neilliae Oestlund.

Oestlund, Geol. and Nat. Hist. Surv., Minn., Bul. 4, p. 59, 1887.

Color.—Viviparae.—Dark olive-green to black, sometimes mottled with lighter green; cornicles and cauda blackish; tibiae pale with black tips.

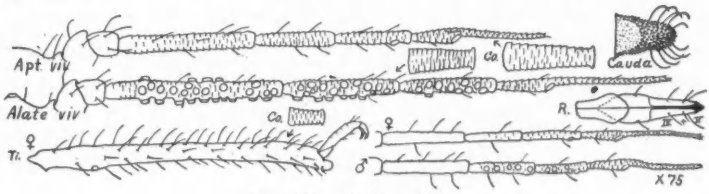


FIG. 143. *Aphis neilliae.*

Measurements.—Apterous summer vivipara.—Body 1.3 to 1.8 by .8 to 1 mm.; hind tibiae .80 to .95 mm.; hind tarsi .10 mm.; antennae .6 to 1.1 mm.; III .13 to .27 mm.; IV .09 to .17 mm.; V .10 to .16 mm.; VI .09 + .15 to .22 mm.; cornicles .09 to .20 mm.; cauda entire length .12 mm.; hard portion .06 mm. Rostrum obtuse, joint IV + V .12 mm. long, attaining between second and third coxae. Alate vivipara.—Same as aptera except antenna 1.1 to 1.22 mm.; III .34 to .43 mm.; IV .20 to .26 mm.; V .16 to .22 mm.; VI .11 + .18 to .22 mm.; cornicles .11 to .14 mm.

Structural Characters.—Secondary sensoria round, conspicuously tuberculate, scattered over entire length of joints, 25 to 37 on III, 14 to 23 on IV, 7 to 15 on V in alatae; absent in apterae; 4 to 5 on IV and V each in male. Hairs pointed, .03 to .04 mm., slightly longer than diameter of antennae or tibiae, semi-erect to erect, fairly numerous. Cornicles cylindrical, imbricated, with flange. Cauda wart-like with slight neck, bearing about 5 hairs on each side. Lateral tubercles large on prothorax and abdominal segments 1 and 7. Fore wings with 2d. fork of media usually nearer the margin than .33 the distance to 1st. fork. Oviparae with hind tibiae slightly swollen proximally and bearing apparently only 1 flat sensorium. Males apterous.

Collections.—On leaves and stems of *Physocarpus ramaleyi* at Fort Collins, Boulder, Manitou and Rocky Mountain National Park; fundatrices Apr. 16 to May 18, apterous summer viviparae June 2 to Aug. 31, alate viviparae June 2 to June 15, sexuales Oct. 29; 15 collections, rather common.

Aphis neomexicana (Cockerell).

Cockerell, Can. Ent., Vol. 33, p. 227, 1901. *Myzus.*

Color.—Viviparae.—Light green; alatae mottled with dark olive-green with black lateral spots on abdominal segments anterior to cornicles and dusky dashes on segments posterior to cornicles; cornicles and cauda pale; legs and antennae pale in apterae, brownish to black in alatae.

Measurements.—Apterous summer vivipara.—Body to base of cauda 1.2 to 2 mm.; hind tibiae .8 to .9 mm.; hind tarsi .11 mm.; antennae .9 to 1.1 mm.; III .22 to .25 mm.; IV .17 to .22 mm.; V .18 to .20 mm.;

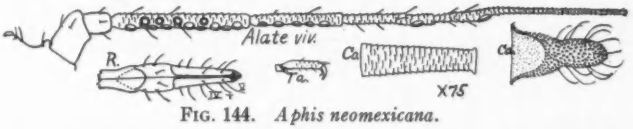


FIG. 144. *Aphis neomexicana.*

VI .11 + .20 to .22 mm.; cornicles .30 to .33 mm.; cauda entire length .17 mm., hard portion .12 mm.; rostrum obtuse, joint IV + V moderately slender, .13 to .15 mm. long, hairy, attaining or slightly surpassing 2d. coxae. Alate vivipara.—Same as aptera except antennae 1.2 mm.; III .25 to .30 mm.; IV .20 to .23 mm.; V .18 to .20 mm.; VI .11 + .28 mm.; cornicles .24 to .30 mm.

Structural Characters.—Secondary sensoria circular, convex, hardly tuberculate, in double row along entire length of joints; on III, 12 to 16; on IV, 6 to 7; rarely 1 on V in alatae; absent in apterae. Hairs pointed, drooping, rather sparse, .02 to .03 mm. long, about as long as diameter of antennae or tibiae. Cornicles cylindrical or slightly tapering, with distinct flange and imbricated. Cauda blunt, cylindrical with slight neck, bearing 5 or 6 lateral hairs and a single dorsal terminal one. Lateral tubercles developed on prothorax and abdominal segments 1 and 7. Fore wings with 2d. fork of media over .33 of distance from margin of wing to 1st. fork.

Collections.—On leaves and stems of *Ribes longiflorum*, not curling leaves, at Fort Collins, Boulder and Rocky Mountain National Park; apterous summer viviparae May 25 to June 23, alate vivipara May 25 to July 8, sexuales not taken; 8 collections, apparently rare.

Taxonomy.—This species differs from *A. ribiensis* in length of cornicles and unguis.

Aphis oenotherae Oestlund.

Oestlund, Geol. and Nat. Hist. Surv., Minn., Bul. 4, p. 62, 1887.

Color.—Viviparae.—Green, olive to dark slaty; slightly powdery; alatae with dark lateral areas and slightly dusky median dashes on abdomen; cornicles and cauda pale to slightly dusky; antennae pale in apterae, dusky in alatae.

Measurements.—Apterous vivipara.—Body 1.5 to 2 mm.; hind tibiae .95 mm.; hind tarsi .11 mm.; antennae 1 to 1.2 mm.; III .22 to .35 mm.; IV .14 to .25 mm.; V .13 to .20 mm.; VI .10 to .14 + .22 to .32 mm.; cornicles .25 to .37 mm.; cauda .18 mm. entire length, .14 mm. hard portion; rostrum obtuse, joint IV + V .13 to .15 mm. long, attaining 3d. coxae. Alate vivipara.—Same as aptera except cornicles .20 to .27 mm. and hind tarsi .10 mm.

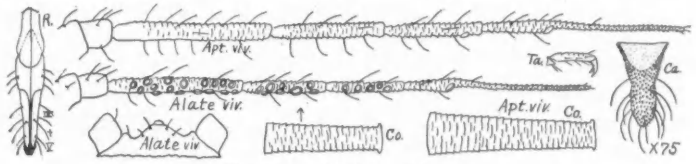


FIG. 115. *Aphis oenotherae.*

Structural Characters.—Secondary sensoria circular, scattered over entire length of joints, 16 to 26 on III; 4 to 16 on IV, 2 to 10 on V in alatae; absent in apterae. Hairs pointed, drooping to nearly erect; .03 to .04 mm. long on antennae and vertex and outer side of tibiae; .06 mm. and curved on cauda. Cornicles cylindrical or slightly tapering, imbricated and with flange. Cauda elongated, nearly parallel-sided with slight neck, bearing 3 lateral and 3 dorsolateral hairs on each side. Lateral tubercles present. Mediae with 2d. fork .33 to .5 the distance from margin of wing to 1st. fork. Males alate.

Collections.—On leaves and stems of *Chamaenerion angustifolium* and *Oenothera biennis*, not curling leaves, generally throughout the state; fundatrices May 13, apterous and alate viviparae May 22 to Oct. 6, oviparae Sept. 17 and Nov. 3, alate males Oct. 18; 40 collections, very common. Often found mingled with *Aphis oestlundi* Gillette.

Taxonomy.—This aphid resembles very closely and may be synonymous with *Aphis epilobii* Kaltenbach. Furthermore, so much variation is found that more than one species may be involved, but no definite line of separation has been found as yet.

Aphis oenotherae var. **rufa** Gillette.

Gillette, Ann. Ent. Soc. Amer., Vol. 20, p. 346, 1927.

Color.—Viviparae.—Pale rusty-yellow; cauda and cornicles hardly darker than body; legs and antennae mostly pale.

Measurements and *Structural Characters.*—Same as in *Aphis oenotherae* Oestlund.

Collections.—On leaves and stems of *Chamaenerion angustifolium* near Cameron Pass; apterous and alate viviparae Aug. 9, 1926; one collection, rare.

Type in U. S. Nat. Mus., Cat. No. 41968; paratypes in collection of Colo. Agr. Exp. Sta.

Aphis oestlundi Gillette.

Gillette, Ann. Ent. Soc. Amer., Vol. 20, p. 345, 1927.

Color.—Viviparae.—Light green; alatae with dusky lateral areas, spots at bases of cornicles and sometimes traces of median dashes on abdomen; cornicles pale in apterae, dusky in alatae; legs pale.

Measurements.—Apterous vivipara.—Body to base of cauda 1.8 to 2 mm.; hind tarsi .08 to .10 mm.; antennae .80 mm. (often 5-jointed); joint III .17 to .22 mm.; IV .10 to .13 mm.; V .10 to .13 mm.; VI

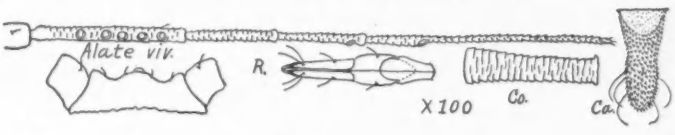


FIG. 146. *Aphis oestlundi.*

.09 + .18 to .22 mm.; cornicles .20 to .30 mm.; cauda .12 mm. hard portion, .15 mm. entire length; rostrum obtuse, joint IV + V slender, .11 to .12 mm. long by .03 mm. wide at base, attaining 3d. coxae or abdomen. Alate vivipara.—Body to base of cauda 1.1 to 1.7 mm.; hind tibiae .60 mm.; hind tarsi .08 to .09 mm.; antennae .80 to 1 mm.; joint III .20 to .23 mm.; IV .10 to .17 mm.; V .11 to .15 mm.; VI .10 + .20 to .27 mm.; cornicles .15 to .20 mm.; cauda .10 mm. hard portion, .12 mm. entire length.

Structural Characters.—Secondary sensoria circular, unusually large, in a single row along almost entire joint, 3 to 6 in number in alate viviparae; absent in apterae. Hairs pointed, fine, sparse, drooping on antennae and vertex .01 mm. long; on hind tibiae .015 mm.; on cauda heavier .04 mm., curved. Cornicles cylindrical, with slight flange, imbricated. Cauda somewhat elongated and constricted near base, bearing 2 or 3 curved hairs on each side. Lateral tubercles well developed on prothorax, and 1st. and 7th. abdominal segments. Fore wings with 2d. fork of media .33 to .5 the distance from margin of wing to 1st. fork.

Collections.—On leaves and stems of *Oenothera biennis* at Fort Collins and Greeley; fundatrices May 13, apterous summer viviparae May 13 to July 6, alate viviparae May 30 to Oct. 18, sexuales not taken; 5 collections, very rare in the state, but abundant in occasional infestations.

Types in U. S. Nat. Mus., Cat. No. 41967; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species is very close to *A. gossypii.* Indeed there seems to be no definite distinguishing character to which exceptions cannot be found. However, the fewer number and larger size of the secondary sensoria in alate viviparae, 3 to 6 in *oestlundi* and 7 to 10 in *gossypii* generally distinguish the two forms. Also tessellated pupae common in *gossypii* have not been observed in *oestlundi.* Furthermore, *oestlundi* on *Oenothera*, though abundant in the east, is very rare in Colorado in spite of the plentiful numbers of *A. gossypii.*

Aphis oregonensis Wilson.

Wilson, Trans. Am. Ent. Soc., Vol. 41, p. 92, 1915.

For taxonomic discussion and fuller description see Gillette and Palmer, Ann. Ent. Soc. of Am., Vol. 21, p. 12 and 13, 1928.

Color.—Viviparae.—Dark brown to wine-red; with broad lateral portions of all segments, including the head, also a pair of dorso-mediolateral areas on metanotum and entire first abdominal segment covered with white reticulations; legs mostly pale yellowish; antennae mostly yellow; cornicles black.

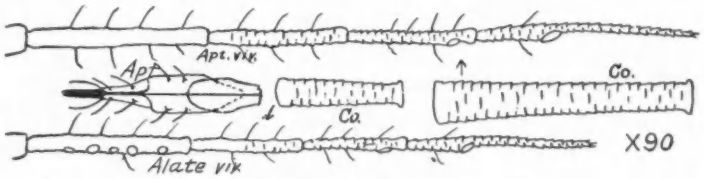


FIG. 147. *Aphis oregonensis.*

Measurements.—Apterous summer vivipara.—Body 1.40 to 1.71 mm.; hind tibiae .55 to .65 mm.; hind tarsi .12 mm.; antennae 1.06 to 1.20 mm.; III .22 to .29 mm.; IV .16 to .23 mm.; V .15 to .20 mm.; VI .10 to .13 + .18 to .21 mm.; cornicles .27 to .42 mm. Alate vivipara.*—Body 1.20 mm.; hind tibiae .55 mm.; antennae 1 to 1.15 mm.; III .20 to .24 mm.; IV .15 to .17 mm.; V .15 to .16 mm.; VI .11 to .12 + .17 to .20 mm.; cornicles .17 to .19 mm.; rostrum acute, joint IV + V .14 mm. long, laterally compressed, tapering, with tip beyond hairs needle-like, .06 mm. by .012 mm. ventrally resembling distinct 5th. joint.

Structural Characters.—Secondary sensoria round and flat, arranged in a single row along most of joint, 4 to 6 in number on antennal joint III in alate viviparae; absent in apterae. Hairs spine-like, rather sparse and inconspicuous, length equaling diameter of antenna. Cornicles cylindrical, with flange, and imbricated. Cauda broadly conical,

*Described from specimens kindly presented by G. F. Knowlton taken May 17, at Brigham, Utah.

blunt, shorter than hind tarsi, bearing 3 curved hairs on each side. Lateral tubercles developed on prothorax and 1st. and 7th. abdominal segments. Mediae of fore wings with 2d. fork between .33 and .5 the distance from margin of wing to 1st. fork.

Collections.—On leaves and tender twigs of *Artemisia tridentata* and *gnaphalodes* at Sargent, Steamboat Springs and Manassa; apterous summer viviparae July 26 to Aug. 11; alate viviparae not taken; 4 collections from Colorado, apparently rather rare, and little collecting has been done in host localities.

Taxonomy.—The examples here described were determined by comparison with Wilson's paratype slides No. 438 kindly loaned us by A. A. Granovsky. For discussion on status of the species see *Aphis cana* Williams.

Aphis ornata Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. of Am., Vol. 22, p. 3, 1929.

Color.—Viviparae.—Pale pinkish or flesh-color, head and pronotum dusky; marked by irregular dusky bands on all segments and lateral areas; legs and antennae pale; cornicles dusky.

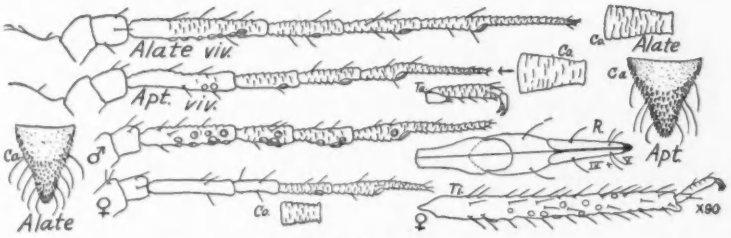


FIG. 148. *Aphis ornata.*

Measurements.—Apterous summer vivipara.—Body 1.8 mm.; hind tibiae .66 to .70 mm.; hind tarsi .11 mm.; antennae .80 to .86 mm.; III .22 to .29 mm.; IV .12 to .16 mm.; V .12 to .16 mm.; VI .11 + .14 to .21 mm.; cornicles .10 to .12 mm.; cauda hard portion .07 mm.; entire length .11 mm.; rostrum obtuse, joint IV + V .14 mm., tip attaining 3d. pair of coxae. Alate vivipara.—Body 1.5 mm. to 1.9 mm.; hind tibiae .66 mm.; hind tarsi .14 mm.; antennae .90 mm.; III .12 to .20 mm.; IV .10 to .11 mm.; V .10 to .13 mm.; VI .09 + .10 to .15 mm.; cornicles .10 to .12 mm.; cauda hard portion .07 mm., entire length .13 mm.

Structural Characters.—Secondary sensoria circular, arranged in rather regular row, 7 to 10 in number on joint III, 1 to 2 on IV in alate viviparae; 1 to 2 on III and 1 on IV in apterous viviparae. Cornicles cylindrical, imbricated, without distinct flange. Cauda conical, rather short, obtuse in apterae, more acute and elongated in alatae, bearing

4 or 5 hairs on each side. Mediae of fore wings with 2d. fork about .5 the distance from margin of wing to 1st. fork. Lateral tubercles present, quite large on prothorax and 1st. and 7th. abdominal segments. Males apterous. Oviparae with hind tibiae slightly swollen and bearing 5 to 9 flat sensoria.

Collections.—On leaves and twigs of *Chrysothamnus graveolens* and *Ratibida columnaris*, but not recorded as noticeably distorting leaves, at Fort Collins and Boulder; apterous summer viviparae June 2 to Oct. 20, alate viviparae June 16 to Aug. 29, oviparae Oct. 11 to Nov. 8, males Oct. 20 and 22; 18 collections, rather common.

Types in U. S. Nat. Mus., Cat. No. 41454; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species is very close to *A. gregalis* Knowlton and may be only a variety or even a synonym. The only differences noted are pink color instead of green in apterous viviparae, and cornicles, especially in apterae, being subequal to distinctly shorter than unguis, instead of subequal to longer. Furthermore, collections of *A. ornata* were all taken on eastern slope of the Rockies and on *Chrysothamnus graveolens* while *A. gregalis* have all been taken west of the Divide and probably on a different species of *Chrysothamnus*. Knowlton's species is reported to cause distortion of leaves while this has not been recorded for our species.

Aphis pentstemonicola Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Am., Vol. 22, p. 23, 1929.

Color.—Viviparae.—Light yellow or greenish-yellow, mottled with darker green; marked with dusky on thorax, lateral areas on all abdominal segments, a patch at bases of cornicles, and dorsal dashes on segments 6, 7 and 8; cornicles, antennae and cauda dark; legs pale to dusky.

Measurements.—Alate vivipara.—Body to base of cauda 1.80 mm.; hind tibiae .75 to .90 mm.; hind tarsi .12 mm.; antennae 1.20 mm.; III .30 to .36 mm.; IV .20 to .25 mm.; V .17 to .20 mm.; VI .12 + .17 to .24 mm.; cornicles .17 to .20 mm.; cauda .12 mm. entire length, .06 mm. hard portion; rostrum obtuse, joint IV + V slender, .12 mm. long, .04 mm. wide at base, attaining between 2d. and 3d. coxae. Apterous vivipara.—Body to base of cauda 1.8 to 2 mm.; hind tibiae 1 mm.; hind tarsi .12 mm.; antennae 1 to 1.3 mm.; III .31 to .40 mm.; IV .21 to .29 mm.; V .17 to .29 mm.; VI .13 + .18 to .27 mm.; cornicles .30 to .38 mm.; cauda .14 mm. entire length, .07 mm. hard portion.

Structural Characters.—Secondary sensoria circular, small, convex but not tuberculate, scattered over entire length of joints, 36 to 43 on III; 15 to 20 on IV; 5 to 9 on V in alatae; 18 to 30 on III, 8 to 15

on IV, 2 to 8 on V in apterae.* Hairs pointed and fairly numerous to sparse, semi-erect; on vertex and antennae .025 to .03 mm. long; on outer side of tibiae .03 to .04 mm.; .04 to .05 mm. long on cauda. Cornicles cylindrical, coarsely imbricated and with flange. Cauda conical, acute, with but slight tendency to constriction near base, bearing three hairs on each side. Mediae of fore wings with 2d. fork from .33 to .5 the distance from margin of wing to 1st. fork. Lateral tubercles large on prothorax and 1st. and 7th. abdominal segments.

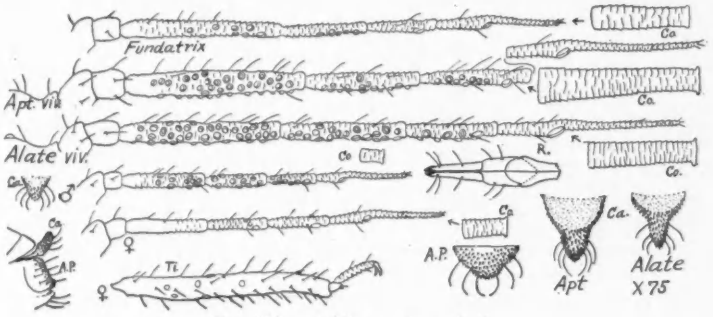


FIG. 149. *Aphis pentstemonicola.*

Anal plate slightly produced on ventral margin. Males apterous. Oviparae with hind tibiae slightly swollen on proximal half and bearing about 6 large scattered sensoria.

Collections.—On leaves and stems of *Pentstemon* sp. near Fort Collins; fundatrix Apr. 23, apterous summer viviparae May 4 to Oct. 20, alate viviparae May 1 to Oct. 20, males Oct. 19 and 20, oviparae Oct. 12 to 20; 21 collections, rather common.

Types in U. S. Nat. Mus., Cat. No. 41465; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species is very close to *Aphis pentstemonis* Will., but differs from cotypes examined in presence of sensoria on antennal joints IV and V, shape of cauda being less constricted, and cauda bearing only 3 hairs on each side. The presence of specimens, on the cotype slides, with a few sensoria on IV and V may indicate that *pentstemonis* is a very variable species and further study may reveal the Colorado form to be an extreme variation. However, none have yet been found in the state without numerous sensoria on IV and V.

*Some apterae, apparently of this species, have sensoria only on distal end of joint and some lack sensoria.

Aphis persicae-niger Smith.

Smith, Ent. Amer., Vol. 6, p. 101, 1890.

Color.—Viviparae.—Shining black; fading into brownish laterally and anteriorly in apterae; cornicles black; antennae dusky to black; cauda and legs yellowish to slightly dusky. Young.—Pale or lemon-yellow, when new-born; in second instar salmon or amber color, later dark yellowish-brown becoming black only in adult instar.

Measurements.—Alate vivipara.—Body to base of cauda 1.60 to 1.80 mm.; hind tibiae 1.10 mm.; hind tarsi .12 mm.; antennae 1.60 to 1.75 mm.; III .46 to .50 mm.; IV .31 to .36 mm.; V .21 to .23 mm.; VI .11 + .50 to .60 mm.; cornicles .23 to .25 mm.; cauda .09 mm. entire length, .04 mm. hard portion; rostrum obtuse, joint IV + V .13 mm. long, attaining between 2d. and 3d. pairs of coxae. Apterous

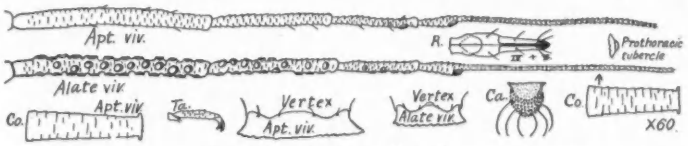


FIG. 150. *Aphis persicae-niger.*

summer vivipara.—Body to base of cauda 1.80 to 2 mm.; cornicles .28 to .30 mm.; other parts as in alatae. Fundatrix.—Same except antennae 1.10 to 1.25 mm.; unguis .17 to .22 mm., hardly more than half of III; hind tibiae .80 mm.; cornicles .20 mm.

Structural Characters.—Secondary sensoria circular, tuberculate, scattered along almost entire length of joints, on III about 42 in three irregular rows, on IV about 21 in two or three rows, on V 3 to 5 in one or two rows; absent in apterae. Hairs pointed, drooping; .01 mm. long on body and antennae; .02 or .03 mm. long on hind tibiae. Dorsal integument smooth. Cornicles cylindrical or slightly tapering with flange and faintly imbricated. Cauda not conical, hardly longer than broad, rounded, wart-like with slight neck, bearing three curved bristles or hairs on either side. Mediae of fore wings with 2d. fork about .5 from margin to 1st. fork. Lateral tubercles vestigial.

Collections.—On bark of twigs and branches of peach,* in Fremont, Delta and Mesa counties; fundatrices Mar. 13 to 23, apterous summer viviparae Mar. 29 to May 4, alate viviparae Mar. 29 to May 1, sexuales not taken; 11 collections, not common.

Aphis phaceliae Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Am., Vol. 22, p. 26, 1929.

Color.—Pale yellowish-green or canary-yellow mottled with bluish-green; cauda pale yellow; cornicles black; legs pale; alatae with dusky

*None have been recorded on roots in the state in spite of considerable searching.

lateral patches on abdomen anterior to cornicles and at bases of cornicles, also with slight median dashes posterior to cornicles.

Measurements.—Alate vivipara.—Body to base of cauda 1.20 to 1.33 mm.; hind tibiae .66 to .80 mm.; hind tarsi .10 mm.; antennae .83 to 1 mm.; III .20 to .28 mm.; IV .14 to .19 mm.; V .10 to .16 mm.; VI .10 + .19 to .23 mm.; cornicles .15 to .20 mm.; cauda .11 mm. entire length, .06 or .07 mm. hard portion; rostrum obtuse, joint IV + V slender, .15 mm., attaining 2d. abdominal segment. Apterous summer vivipara.—Same as alata except cornicles .20 to .28 mm.; cauda .13 mm. entire length, hard portion .08 mm.

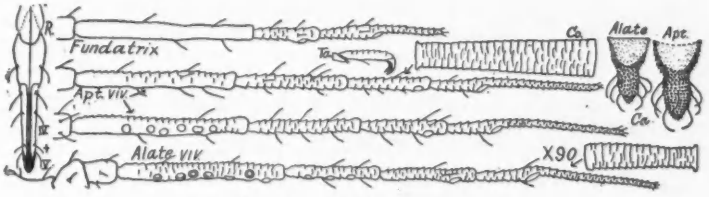


FIG. 151. *Aphis phaceliae.*

Structural Characters.—Secondary sensoria circular rather large, not tuberculate, usually in a single row 7 to 12 in number on joint III, 1 to 3 on IV, 0 on V in alatae; absent or 5 to 7* on III in apterae. Hairs pointed, drooping, .02 to .03 mm. long on body and antennae. Cornicles cylindrical, with slight flange, imbricated. Cauda elongate, parallel-sided, with slight constriction or neck near base, bearing 3 hairs on each side. Lateral tubercles present on prothorax and 1st. and 7th. abdominal segments. Mediae of fore wings with 2d. fork about .5 the distance from margin of wing to 1st. fork. Male unknown.

Collections.—On leaves and stems of *Phacelia* sp. near Fort Collins, Bellvue and Boulder; fundatrix Apr. 15, apterous summer viviparae June 1 and 7 and Sept. 22, alate viviparae May 16 to June 7, oviparae Sept. 22, males not taken; 6 collections, not common.

Types in U. S. Nat. Mus., Cat. No. 41466; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species is closely allied to *Aphis gossypii* Glover but differs in rostrum being longer, second fork of media being about one-half, often more, of distance from margin of wing to first fork; in constancy of sensoria on antennal joint IV in alate viviparae; cauda with hard portion shorter than hind tarsi; and rostrum attaining abdomen. Also sensoria occasionally occur on antennal joint III of the apterous viviparae.

*Found in two examples out of eight specimens taken.

Aphis pilosicauda Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Am., Vol. 25, p. 141, 1932.

Color.—Viviparae.—Olive-green; lateral areas dusky in alatae; dorsum slightly powdery in apterae; cauda, cornicles and antennae dusky to black; legs in apterae yellowish, dusky in alatae.

Measurements.—Alate vivipara.—Body 1.5 to 1.9 mm.; hind tibiae .65 to .80 mm.; hind tarsi .11 mm.; antennae .80 to 1.05 mm.; III .19 to .22 mm.; IV .11 to .12 mm.; V .11 to .13 mm.; VI .11 + .28 to .35 mm.; cornicles .22 to .25 mm.; cauda .08 mm. on hard portion, .12 mm. entire length; rostrum obtuse, joint IV + V rather slender, .18 mm. long, attaining 1st. segment of abdomen. Apterous summer vivipara.—Same as alata except cornicles .25 to .30 mm. and rostrum attaining 2d. or 3d. abdominal segment.

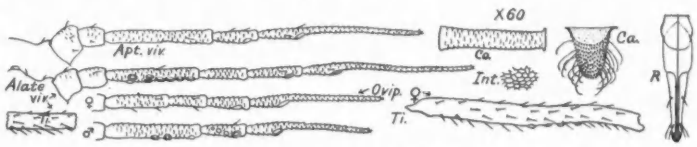


FIG. 152. *Aphis pilosicauda.*

Structural Characters.—Secondary sensoria circular, flat, arranged in single row along almost entire length of III, 6 to 7 in number, 0 on IV and V; absent in apterae. Hairs pointed, fine, sparse, .01 mm. long on vertex, antennae and outer side of hind tibiae; on cauda fine, curved, .05 mm. long. Cornicles cylindrical, rather slender, about as wide as hind tibiae, imbricated and with flange. Cauda blunt, conical to cylindrical, slightly longer than wide, bearing about 8 hairs on each side. Lateral tubercles present on prothorax and abdominal segments 1 and 7. Fore wings with 2d. fork of media .33 or slightly more of the distance from margin of wing to 1st. fork. Oviparae with hind tibiae very slightly swollen in middle and bearing about 1 to 4 hardly visible sensoria. Males apterous.

Collections.—On stem of *Cirsium* sp. near ground or on roots near Fort Collins and Boulder; apterous summer viviparae June 19 to Sept. 18, alate viviparae June 11 to July 18, apterous oviparae Oct. 4 to 30, apterous males Oct. 30; 10 collections, not abundant.

Types in U. S. Nat. Mus., Cat. No. 43845; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species is distinguished from *Aphis carduella* Walsh by fewer sensoria and conical cauda without constriction.

Aphis pomi DeGeer.

DeGeer, Mems. des. Ins., Vol. 3, p. 53, 1773.

Color.—Viviparae.—Light yellowish-green or apple-green; alatae with darker green spots laterally but not true dusky areas; cauda, legs and antennae pale or slightly dusky; cornicles black.

Measurements.—Alate vivipara.—Body to base of cauda 1.50 to 1.90 mm.; hind tibiae 1 mm.; hind tarsi .11 or .12 mm.; antennae 1.15 to 1.30 mm.; III .25 to .34 mm.; IV .20 to .23 mm.; V .19 to .21 mm.; VI .12 + .29 to .34 mm.; cornicles .29 to .30 mm.; cauda .17 mm. entire length, .12 mm. hard portion; rostrum obtuse, joint IV + V .14 mm. long, attaining between 2d. and 3d. coxae. Apterous summer vivipara.—Same as alate vivipara except cornicles .40 mm. and cauda .19 mm.

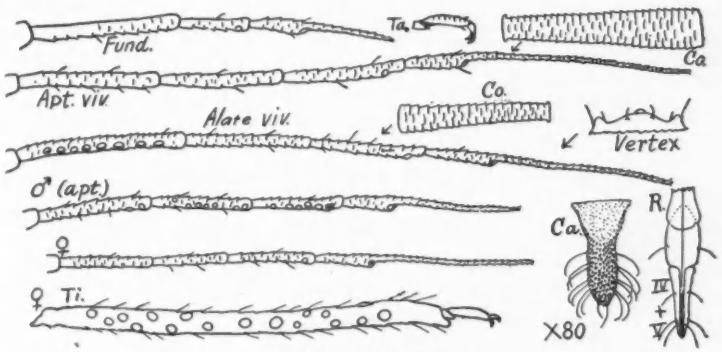


FIG. 153. *Aphis pomi.*

Structural Characters.—Secondary sensoria circular, rather large and flat, arranged in single row along nearly entire joint, 6 to 9 on III, none on IV and V in alate viviparae; absent in apterous viviparae. Hairs pointed, drooping; .04 mm. long on body and .02 mm. on antennae; long and curved on cauda. Cornicles cylindrical or slightly tapering, with flanges and imbricated. Cauda elongated-cylindrical, with only slight tendency to constriction at neck and blunt at tip, bearing 4 lateral and 3 dorsolateral hairs on each side and a median pair near tip. Lateral tubercles present on prothorax and all abdominal segments except the 8th. Media of fore wings with second fork between .33 and .5 the distance from margin of wing to 1st. fork. Males apterous.* Oviparae smaller than viviparae and with tibiae pale, not swollen and bearing only scattered, large, slightly convex sensoria.

Collections.—On leaves and twigs of *Pyrus Malus* (apple, *Pyrus communis* (pear), *Crataegus* sp. and *Sorbus* sp. generally

*Label, "Alate ♂" in Jo. Ec. Ent., Vol. 1. Plate 6, Fig. 4, 1908 and Colo. Exp. Sta. Bul. 133, p. 58, should read "apterous ♂."

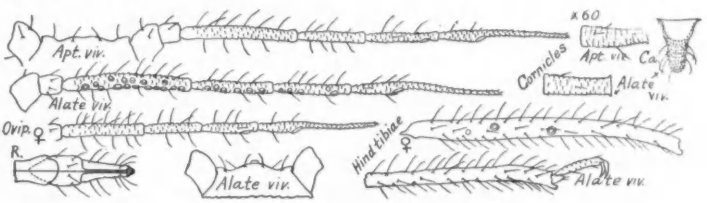
throughout the state; fundatrices Mar. 18 to April 28, apterous summer viviparae May 22 to Sept. 28, alate viviparae April 22 to Oct. 17, sexuales Sept. 16 to Oct. 20; very common and causing considerable damage.

Aphis pseudovalerianae Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 25, p. 143, 1932.

Color.—Viviparae.—Light olive-green; with dusky lateral areas and bands on terminal segments; cauda, cornicles, antennae and legs brown to black.

Measurements.—Alate vivipara.—Body 1.5 to 1.8 mm.; hind tibiae .80 mm.; hind tarsi .12 mm.; antennae 1.05 to 1.30 mm.; III .25 to .32 mm.; IV .17 to .20 mm.; V .19 to .20 mm.; VI .13 + .22 to .25 mm.; cornicles .16 to .18 mm.; cauda .08 mm. hard portion, .14 mm. entire length; rostrum obtuse, joint IV + V .13 mm. long, attaining 3d. coxae. Apterous summer vivipara.—Same as alata except rostrum attains 1st. segment of abdomen.



FG. 154. *Aphis pseudovalerianae.*

Structural Characters.—Secondary sensoria circular, rather small, slightly convex, hardly tuberculate, scattered along entire joints, 14 to 20 on III, 3 to 7 on IV, 1 to 5 on V in alate viviparae; absent in apterae. Hairs pointed, numerous, erect; on vertex, antennae and outer side of tibiae .03 to .05 mm. Cornicles cylindrical with flange, imbricated, bearing 2 to 4 hairs on proximal half. Cauda cylindrical, broad and obtuse, with about 5 hairs on each side. Lateral tubercles present and large on pronotum and abdominal segments 1 and 7. Fore wings with 2d. fork of media between .33 and .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae very slightly swollen and bearing 2 or 3 irregular-sized faint sensoria. Males unknown.

Collections.—On root of *Valeriana* sp. at Log Cabin and Fort Collins; apterous and alate summer vivipara July 11 to Aug. 2, apterous ovipara Sept. 7 and 10; 5 collections, apparently rare.

Types in U. S. Nat. Mus., Cat. No. 43843; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species differs from *Aphis valerianae* Cowen in the longer, erect hairs; presence of hairs on cornicles;

lighter color; shorter antennal joints and cornicles and sensoria not tuberculate.

Aphis ribiensis Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 22, p. 20, 1929.

Color.—Viviparae.—Pale to medium yellowish-green or apple-green; cornicles, cauda and tibiae pale to slightly dusky; antennae pale to dusky.

Measurements.—Alate vivipara.—Body to base of cauda 1.80 mm.; hind tibiae .85 mm.; tarsi .10 mm.; antennae .95 mm.; III .22 to .26 mm.; IV .16 mm.; V .13 to .5 mm.; VI .11 + .18 to .22 mm.; cornicles .10 to .15 mm. long, slightly wider than hind tibiae; cauda .19 mm. entire length, hard portion .10 mm.; rostrum obtuse, joint IV + V .10 mm. long, .04 mm. wide at base, hardly attaining 2d. coxae. Apterous vivipara.—Same as alata except cornicles .15 to .20 mm.

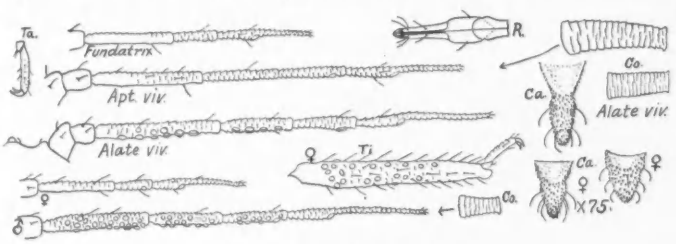


FIG. 155. *Aphis ribiensis.*

Structural Characters.—Second sensoria circular, rather large, arranged in irregular partly double row along entire length of joint, 9 to 20 on III, 4 to 5 on IV, 0 on V; absent in apterae. Hairs pointed, drooping, .01 to .02 mm. long. Cornicles cylindrical, imbricated and with flange. Cauda elongate blunt and with slight neck and bearing two or three pairs of lateral hairs; tubercles present. Mediae of fore wings with 2d. fork .33 the distance from margin of wing to 1st. fork. Males alate. Oviparae with hind tibiae moderately swollen and bearing about 20 large sensoria scattered over .66 of length.

Collections.—On leaves and stems of *Ribes longiflorum* (formerly called *aureum*), curling leaves at Fort Collins; fundatrix May 26, apterous summer viviparae (very rare and possibly fundatrices) May 26, alate viviparae May 31 and Sept. 11 to Nov. 9, sexuales Oct. 17 to Nov. 9; 13 collections, rather abundant.

Types in U. S. Nat. Mus., Cat. No. 41463; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species appears closely allied to *Aphis sanborni* Patch but differs in tendency to more numerous

sensoria on antennae of alatae, shorter and wider cornicles and twice as many hairs on cauda. It differs from *Aphis ribis* Sanborn in more numerous sensoria and shorter antennal joints and cornicles. From *Aphis monardae* Oestlund it differs in larger body and shorter cornicles.

Aphis rociadae Cockerell.

Cockerell, Tr. Amer. Ent. Soc., Vol. 29, p. 115, 1903.

For fuller description see Davis, Can. Ent., Vol. 51, p. 228, 1919.

Color.—Apterous vivipara.—Reddish-brown or russet to black fading to hazel anteriorly and posteriorly; shining; cauda, cornicles, legs and antennae yellowish to pale brownish, especially distally. Alate vivipara.—Same color as aptera except dusky bands on abdominal segments 4, 5, 6 and 7 and lateral areas on segments 2, 3, 4 and 5; head and thorax dark brown. Nymphs.—Coral red.

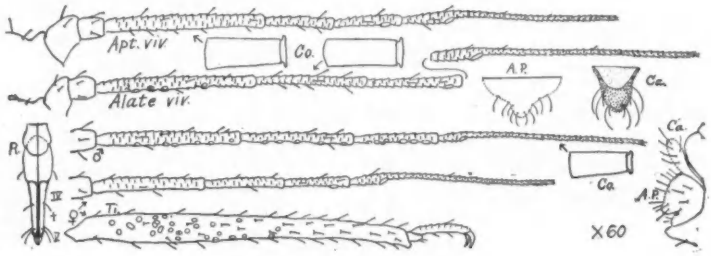


FIG. 156. *Aphis rociadae.*

Measurements.—Alate vivipara.—Body 1.8 to 2 mm.; hind tibiae 1.15 to 1.30 mm.; hind tarsi .13 mm.; antennae 1.45 to 1.70 mm.; III .38 to .45 mm.; IV .24 to .32 mm.; V .22 to .25 mm.; VI .10 + .50 to .60 mm.; cornicles .17 to .22 mm.; cauda .10 mm. entire length, .06 to .07 mm. hard portion. Apterous summer vivipara.—Body 2 by 1.20 mm.; hind tibiae 1 mm.; hind tarsi .13 mm.; antennae 1.30 to 1.60 mm.; III .30 to .43 mm.; IV .21 to .29 mm.; V .19 to .22 mm.; VI .11 + .37 to .50 mm.; cornicles .17 to .20 mm.; rostrum obtuse, joint IV + V moderately slender .14 to .15 mm. long, .05 mm. wide at base, attaining between 2d. and 3d. coxae.

Structural Characters.—Secondary sensoria round, flat, inconspicuous, antennal joint slightly swollen about sensoria, 1 to 4 on III, none on other joints in alate viviparae; absent in apterous viviparae. Hairs blunt or slightly capitate .015 to .02 mm. long and at angle of 35 to 45 degrees on antennae; .03 to .04 mm. long on body and hind tibiae; neither sparse nor numerous; on cauda, pointed, .05 or .06 mm. long and curved. Cornicles cylindrical or slightly tapering with distinct flange, smooth. Cauda short, nearly as broad as long, parallel-sided with obtusely conical tip, bearing 3 lateral and 2 dorsolateral pairs of hairs. Anal plate with wart-like median protuberance. Both cauda

and anal plate retracted under terminal segments of abdomen, giving body broadly rounded appearance posteriorly. Lateral tubercles not apparent. Mediae of fore wings with 2d. fork from slightly over .33 to slightly over .5 the distance from margin of wing to 1st. fork. Males apterous, with about 6 sensoria on antennal joint III, 5 on IV, 6 on V. Oviparae with hind tibiae slightly swollen in proximal half and bearing scattered flat sensoria and with antennae lacking sensoria.*

Collections.—On leaves and stems of *Delphinium* sp. near Denver, Pueblo, Colorado Springs and Fort Collins; apterous summer viviparae May 14 to June 23 and Sept. 2, alate viviparae May 14 to June 21, sexuales Oct. 3; 9 collections, rather rare.

Taxonomy.—This species seems to stand alone on account of the following peculiarities; retracted tip of abdomen, protuberance on anal plate, smooth cornicles, flat and inconspicuous sensoria, and the bright red color of the nymphs.

Aphis rosea (Baker).

Baker, Can. Ent., Vol. 53, p. 95, 1921. *Anuraphis;* also Jour. Agr. Res., Vol. 7, p. 325, 1916. *Aphis malifoliae* Fitch.

Color.—Apterous viviparae.—Amber to salmon to dark green; slightly pulverulent. Alate viviparae.—Rusty-brown on abdomen with dark dorsal patch and lateral areas; cornicles dark; legs amber color.

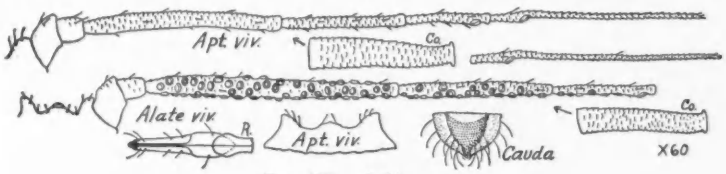


FIG. 157. *Aphis rosea.*

Measurements.—Apterous summer vivipara.—Body 2.25 by 1.50 mm.; hind tibiae 1 mm.; antennae 1.85 mm.; III .45 to .60 mm.; IV .25 to .43 mm.; V .23 to .28 mm.; VI .10 to .13 + .45 to .50 mm.; cornicles .35 to .39 mm.; cauda .05 mm. hard portion, .08 mm. entire length; rostrum obtuse, joint IV + V slender, .15 mm. long, attaining between 2d. and 3d. coxae. Alate vivipara.—Body 1.8 to 2 mm.; hind tibiae 1.2 mm.; hind tarsi .10 mm.; antennae 2 mm.; III .55 to .74 mm.; IV .39 to .48 mm.; V .25 to .32 mm.; VI .10 to .14 + .53 to .60 mm.; cornicles .28 to .33 mm.; cauda .09 mm. entire length, hard portion .07 mm.; rostrum not surpassing 2d. coxae.

Structural Characters.—Vertex convex; antennal tubercles produced on inner margin, twice as much as vertex, bearing slightly capitate hairs. Antennae finely imbricated. Hairs inconspicuous, blunt or capitate, .02 mm. long on antennae, tibiae and vertex of alatae; on

*Sexuales described by Davis (Can. Ent., Vol. 51, p. 229) were evidently not this species.

vertex of apterae .04 mm. Secondary sensoria circular, tuberculate, scattered over entire length of joints, 50 to 60 on III, 20 to 30 on IV and 3 to 8 on V; absent in apterae. Cornicles imbricated, cylindrical or slightly curved outward distally and with flange. Cauda very short, hardly apparent, conical, acute, bearing 3 pairs of lateral hairs. Anal plate with slight median protuberance. Lateral tubercles well developed a pair of dorsal tubercles on head and abdominal segments 7 and 8. Surface of dorsum smooth. Mediae of fore wings with 2d. fork about .5 the distance from margin of wing to 1st. fork.

Collections.—On leaves and twigs of *Pyrus Malus* and *Pyrus communis*, curling leaves, on western slope of Rocky Mountains; fundatrices April 20 to May 8, apterous summer viviparae May 20 to July 23 and Sept. 20, alate viviparae April 27 to July 23, sexuales not taken; 19 collections, abundant.

Taxonomy.—This form was mentioned as *Aphis pyri* Boyer by Gillette and Taylor (Col. Agr. Exp. Sta. Bul. 133, p. 31, 1908).

Aphis rubicola Oestlund.

Oestlund, Geol. and Nat. Hist. Surv. Minn., Bul. 4, p. 60, 1887.
See also Winter, Ent. News, Vol. 40, p. 193, 1929.

Color.—Viviparae.—Greenish or yellowish; appendages pale.

Measurements.—Alate vivipara.—Body 1.20 to 1.50 mm.; hind tibiae .72 to .85 mm.; hind tarsi .09 mm.; antennae .85 to 1 mm.; III .24 to .29 mm.; IV .14 to .16 mm.; V .10 to .15 mm.; VI .10 + .18 to .20 mm.; cornicles .17 to .23 mm.; cauda .07 mm. hard portion, .13 mm. entire length; rostrum obtuse, joint IV + V slender, .13 mm. long by .05 mm. wide at base, attaining between 2d. and 3d. coxae.

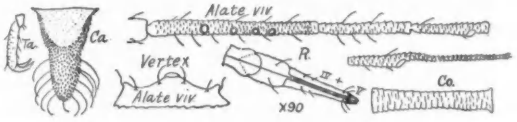


FIG. 158. *Aphis rubicola.*

Structural Characters.—Secondary sensoria round, with diameter exceeding .5 that of antennal joint, arranged in single row, 4 to 6 in number on III, 0 to 1 on IV, 0 on V in alate viviparae. Hairs pointed, .015 to .02 mm. on antennae and tibiae; .03 mm. on antennae and body; on cauda .05 mm. long and curved. Cornicles approximately cylindrical, narrower in middle, with slight tendency to swelling in distal half and with slight flange, imbricated rather coarsely. Cauda elongate-conical, rounded at tip with slight tendency to constriction near base, bearing 5 or 6 pairs of lateral hairs. Lateral tubercles present, quite large on prothorax and 7th. abdominal segment. Fore wing with 2d. fork of media .33 to .5 the distance from margin of wing to 1st. fork.

Collections.—On leaves of *Rubus* sp. at Fort Collins and Boulder; alate viviparae June 2 to 16; 2 collections, rare.

Taxonomy.—This species resembles *Cerosipha rubifolii* (Thomas) (8th. Rept. St. Ent., Vol. 3, p. 121, 1879, *Sipha.*), but differs in number of antennal joints, shape of cornicles and hairs on cauda.

Aphis rumicis Linnaeus.

Linnaeus, Syst. Nat., Ed. 10, p. 451, 1758.

For fuller description see Davidson, J., Bul. Ent. Res., Vol. 12, p. 81, 1921.

Color.—Viviparae.—Dark olive-green to black; cauda and cornicles black; legs and antennae mostly pale. Nymphs of alatae blackish except meso- and meta-thorax which are pale green; abdomen tessellated, with 4 rows of powdery spots on dorsum.

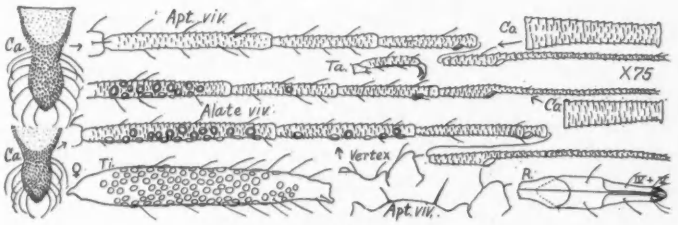


FIG. 159. *Aphis rumicis.*

Measurements.—Apterous summer vivipara.—Body 1.8 to 2.20 mm.; hind tibiae 1.05 mm.; hind tarsi .15 mm.; antennae 1.40 mm.; III .27 to .36 mm.; IV .14 to .25 mm.; V .16 to .22 mm.; VI .11 + .27 to .35 mm.; cornicles .23 to .29 mm.; cauda .25 mm. entire length, .15 mm. hard portion. Alate viviparae.—Same as aptera except cornicles .21 to .27 mm. and cauda .17 mm. entire length, .10 mm. hard portion; rostrum obtuse with joint IV + V rather slender, .13 to .15 mm. long, attaining 2d. to 3d. coxae.

Structural Characters.—Secondary sensoria not tuberculate, round, with diameter from .33 to .5 diameter of antennal joint bearing them, scattered along entire length of joint, 12 to 18 on III, 0 to 6 on IV, 0 on V in summer alatae; in fall alatae often as many as 20 on III and 7 on IV; absent in apterae. Hairs pointed .03 to .04 mm. long on antennae, vertex and tibiae; .07 or .08 mm. and curved on cauda. Cornicles cylindrical or slightly tapering, with flange and finely imbricated. Cauda cylindrical with tendency to constriction, or spoon-shaped and bearing 3 to 4 lateral and 3 dorsolateral hairs on each side. Lateral tubercles well developed on prothorax and abdominal segments 1 and 6, quite small on remaining segments. Mediae with 2d. fork slightly over .33 the distance from margin of wing to 1st. fork. Males alate.

Collections.—On leaves and stems of *Aragallus albiflorus*, *Arctium Lappa*, *Beta vulgaris*, *Capsella Bursa-pastoris*, *Curcurbita maxima*, *Dahlia* sp., *Enonymus* sp., *Gonophryea* sp., *Helichrysum* sp. *Lactuca sativa*, *Rumex* sp., *Urtica gracilis*, *Viburnum Opulus*, and *Zea Mays* generally throughout the state; fundatrices May 7, apterous summer viviparae May 7 to Nov. 15, alate viviparae June 26 to Oct. 27, sexuales Oct. 20 to 27; 27 collections, common.

Aphis saliceti Kaltenbach.

Kaltenbach, Mon, der Pflanzenlause, p. 103, 1843.

Color.—Viviparae.—Green, often pinkish; apterae and nymphs of alatae with slight tessellation; alatae with lateral areas on all segments and dorsal bands on 7th. and 8th. of abdomen dusky; cornicles pale with dusky tips.

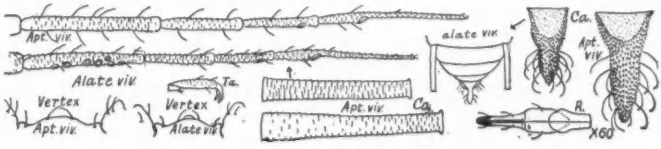


FIG. 160. *Aphis saliceti.*

Measurements.—Apterous summer vivipara.—Body 1.6 to 2 mm.; hind tibiae .95 mm.; hind tarsi .12 mm.; antennae 1.25 mm.; III .30 to .37 mm.; IV .20 to .23 mm.; V .21 to .22 mm.; VI .13 + .23 to .26 mm.; cornicles .50 to .55 mm.; cauda .25 to .27 mm. entire length, .15 to .19 mm. hard portion. Alate vivipara.—Same as aptera except antennae 1.05 to 1.15 mm.; III .25 to .33 mm.; IV .16 to .21 mm.; V .16 to .21 mm.; VI .13 + .18 to .28 mm.; cornicles .35 to .40 mm.; cauda .18 mm. entire length, .11 mm. hard portion; rostrum obtuse, joint IV + V rather slender, .12 mm. long, attaining between 2d. and 3d. coxae.

Structural Characters.—Dorsal surface reticulated, especially in apterae. Secondary sensoria round, from .33 to .5 diameter of 3d. antennal joint, arranged in single row along almost entire length of joint III, 7 in number, 0 on IV or V in alatae; absent in apterous viviparae. Hairs pointed, to blunt, drooping, .02 to .03 mm. long and rather sparse on antennae and tibiae; .05 to .07 mm. long, and curved on cauda. Cornicles cylindrical to tapering, with flange and distinctly imbricated. Cauda elongate with acute tip, conical to parallel-sided, in apterous viviparae rather macrosiphum-like, bearing 3 or 4 ventrolateral and 3 or 4 dorsolateral pairs of hairs. Eighth abdominal segment without dorsal tubercle. Lateral tubercles well developed. Mediae with 2d. fork not over .33 the distance from margin of wing to 1st. fork, occasionally obsolete. Males apterous. Oviparae with hind tibiae slightly swollen on proximal .33 and bearing a few sensoria.

Collections.—On leaves and twigs of *Salix* sp. at Fort Collins, Lyons, Colorado Springs, Rabbit Ears Pass, Steamboat Springs, and Antonito; apterous summer viviparae May 18 to Aug. 20, alate viviparae June 10 to Aug. 20, oviparae June 11 to Aug. 11, males June 11 to July 14; 17 collections, hardly common.

Taxonomy.—This is the species published as *Aphis salicicola* Thos., by Gillette (Jo. Ec. Ent., Vol. 3, p. 403).

Aphis sambucifoliae Fitch.

Fitch, Rept. Reg. Univ. St. N. Y. Cab. Nat. Hist., p. 66, 1851.

Color.—Viviparae.—Blackish-green with dusky bands on terminal segments of abdomen of apterous viviparae; white tesselations on nymphs of alatae and on 6th. and 7th. abdominal segments of occasional adult apterae, especially in intermediate forms*; appendages dusky brown to blackish. New-born young.—Rather bright light green with tan-colored head. Oviparae.—Olive-yellow.

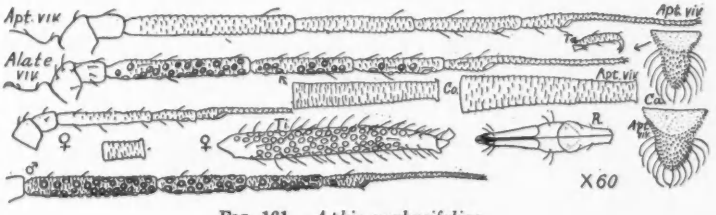


FIG. 161. *Aphis sambucifoliae.*

Measurements.—Apterous vivipara.—Body 2 to 2.5 mm.; hind tibiae 1 to 1.25 mm.; hind tarsi .12 mm.; antennae 1.4 to 1.8 mm.; III .38 to .44 mm.; IV .26 to .34 mm.; V .22 to .29 mm.; VI .12 to .15 + .30 to .38 mm.; cornicles .40 to .65 mm.; cauda .17 mm. entire length, .09 mm. hard portion. Alate vivipara.—Body 2 to 2.3 mm.; hind tibiae 1.2 mm.; antennae 1.3 to 1.5 mm.; III, .32 to .37 mm.; IV .22 to .30 mm.; V .21 to .28 mm.; VI .14 + .30 to .38 mm.; cornicles .36 mm.; cauda .08 mm. hard portion; rostrum obtuse, joint IV + V rather slender, .15 mm. by .06 mm. at base, attaining 3d. coxae.

Structural Characters.—Secondary sensoria circular, scattered along whole length of joints, in alate viviparae, 19 to 30 on III, 3 to 13 on IV, and 0 to 8 on V; somewhat more numerous on III, IV, and V in males; absent in apterae, except in intermediate. Hairs very short and inconspicuous, .02 to .03 mm. long on antennae, and vertex; on cauda .05 or .06 mm. long and curved. Cornicles cylindrical or somewhat tapering, closely imbricated and with flange. Lateral tubercles large, especially on prothorax. Cauda broad and blunt, with slight constriction near base, with 6 lateral and dorsolateral pairs of hairs.

*Adult forms with abortive wing pads.

Mediae of fore wings with 2d. fork from .33 to .5 the distance from margin of wing to 1st. fork. Males alate. Oviparae with cornicles short, subequal to hind tarsi and with hind tibiae swollen throughout and covered with numerous sensoria.

Collections.—On twigs and leaves of *Sambucus microbotrys* near Ft. Collins; fundatrices Apr. 24 and May 2, apterous summer viviparae May 31 to Oct. 5, alate viviparae May 31 to Oct. 16, sexuales Oct. 5 to 16; 20 collections, fairly common.

Taxonomy.—This species has been considered by some as synonymous with *Aphis sambuci* L. but Theobald (Aph. Gr. Brit., Vol. 2, p. 95, 1927) and Van der Goot (Holland, Blattlause p. 231, 1915) mention sensoria on antennal joints IV and V as 0 to 1, while the Colorado forms observed, all have several sensoria on IV and V, very rarely one or none on V. Cornicles in our form are also shorter, and rostrum more slender, as compared with specimens received from D. H. R. Lambers, from Wageningen, Holland. There is considerable resemblance to *Aphis sambucaria* Pass. as described by Theobald (Aph. Gr. Brit., Vol. 2, p. 149, 1927), but the cauda is much less than half of cornicle, the proportion given by Theobald for Passerini's species.

Aphis senecio-radicis (Gillette and Palmer)

Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 22, p. 9, 1929. *Anuraphis.*

Color.—Viviparae.—Dusky blue-green; slightly pulverulent; apterae shading to brownish on head, and with dusky band on terminal segments; alatae dusky on lateral areas of all segments and dashes on dorsum of 7th. and 8th. abdominal segments; antennae, legs, cornicles and cauda dusky to black throughout.

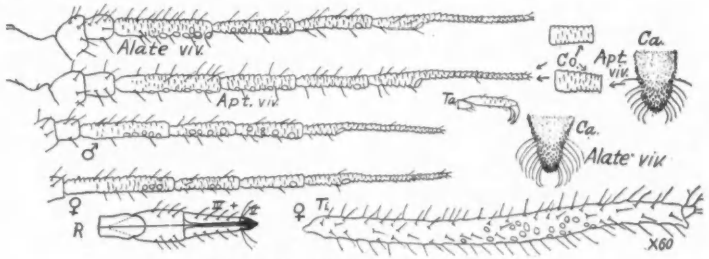


FIG. 162. *Aphis senecio-radicis.*

Measurements.—Apterous summer vivipara.—Body 2.80 mm. by 1.70 mm.; hind tibiae .90 to 1.05 mm.; hind tarsi .13 mm.; antennae 1.25 mm.; III .26 to .31 mm.; IV .20 to .25 mm.; V .18 to .22 mm.; VI .14 to .18 mm. + .25 to .32 mm.; cornicles .10 to .14 mm.; cauda

entire length .18 mm., hard portion .09 mm. Rostrum obtuse, joint IV + V .20 mm. long by .07 mm. at base, and hairy, attaining 1st. or 2d. abdominal segments. Alate vivipara.—Body 2.2 mm.; hind tibiae and antennae as in apterae; cornicles .09 to .11 mm.; cauda entire length .14 mm., on median line of hard portion .08 to .09 mm.

Structural Characters.—Secondary sensoria round, not tuberculate, medium in size, arranged in rather irregular row on posterior side of joints, 5 to 8 on III, 1 to 6 on IV in alate viviparae; in apterous viviparae, variable in size, 1 to 5 on III, 1 to 5 on IV, 0 on V. Hairs fine, pointed, moderately numerous and erect, length equal to diameter of antennae. Cornicles imbricated, cylindrical, without evident flange. Cauda obtusely conical with only a very slight suggestion of constriction, bearing 7 hairs on each side. Lateral tubercles present on all segments anterior to cornicles, but not observed posteriorly. Mediae of fore wings with 2d. fork variable from absence to .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae slightly swollen distally to middle and bearing 10 to 24 sensoria. Males apterous.

Collections.—On roots of *Senecio spartioides* and sp. at Grand Mesa, northern Routt County, Fort Collins, Colorado Springs, and Virginia Dale; apterous summer viviparae July 25 to Sept. 21, alate viviparae Aug. 16 to Sept. 21, sexuales Oct. 30; 15 collections, not very common.

Types in U. S. Nat. Mus., Cat. No. 41457; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species approaches *A. middletonii* but is distinguished by absence of dorsal markings on apterous summer viviparae; unguis not shorter than III, usually longer; cornicles shorter, not longer than hind tarsi (to claws); rostrum longer, attaining 1st. or 2d. abdominal segment; and hairs erect, more numerous and longer, length equaling diameter of antennae, also the more slender hind tibiae of oviparae bearing fewer sensoria.

Aphis sensoriata Gillette and Bragg.

Gillette and Bragg, Jour. Ec. Ent., Vol. 11, p. 330, 1918.

Color.—Viviparae.—Black throughout, except fundatrices which are rusty-red to chestnut-brown; cornicles in apterae pale and with pale areas about base; legs and antennae slightly dusky.

Measurements.—Apterous vivipara.—Body 2 to 2.25 mm.; hind tibia .80 mm.; antennae 1 to 1.1 mm.; III .27 to .50 mm.; IV .19 to .23 mm.; V .18 mm.; VI .10 + .20 to .35 mm.; cornicles .14 mm.; cauda .05 mm. hard portion; rostrum obtuse, joint IV + V .14 to .17 mm. long by .05 to .06 mm. wide at base and hairy, attaining or surpassing 3d. coxae. Alate vivipara.—Body 2 mm.; hind tibiae .9 to 1 mm.; hind tarsi .12 mm.; antennae 1.2 mm.; III .34 to .37 mm.; IV .24 mm.; V .20 to .22 mm.; VI .10 to .12 + .26 to .29 mm.; cornicles

.12 mm.; cauda .05 mm. hard portion. Rostrum attaining between 2d. and 3d. coxae.

Structural Characters.—Antennae with base of VI abruptly constricting to unguis. Secondary sensoria oval, somewhat tuberculate, in alate viviparae, scattered along entire length of joints III, IV and V, 36 on III, 12 on IV, and 6 on V; sometimes present in apterous viviparae on joints III and IV. Hairs pointed, rather numerous, drooping to semi-erect, .02 to .03 mm. long on vertex, antennae and tibiae. Cornicles tapering, with flange, and with setulose imbrications. Cauda short, hardly evident, much broader than long, conical, rounded at

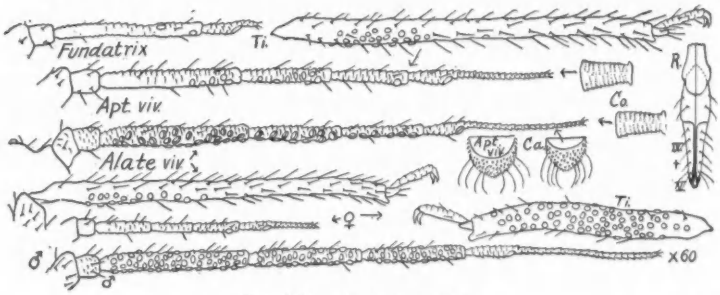


FIG. 163. *Aphis sensoriata.*

tip, with about 3 hairs on each side. Mediae of fore wings with 2d. fork .5 more or less of the distance from margin of wing to 1st. fork. All viviparae with hind tibiae swollen on proximal half and bearing large circular sensoria over almost entire tibiae. Oviparae with entire hind tibiae swollen, bearing scattered sensoria. Males alate.

Collections.—On leaves and twigs of *Amelanchier spicata* (?) near Log Cabin, Larimie-Poudre Tunnel and Hesperus, all above altitude of 8000 ft.; fundatrices May 26, apterous viviparae July 12 to Aug. 25, alate viviparae July 27 to Oct. 1, sexuales Oct. 1; seven collections, rather rare.

Types in U. S. Nat. Mus., Cat. No. 41927; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species is very close to *Aphis brevis* Sanderson, but differs in the presence of sensoria on hind tibiae of viviparae and more rounded tip and less tendency to constriction in cauda.

Aphis setariae (Thomas).

Thomas, Bul. Ill. St. Lab. Nat. Hist., Vol. 1, p. 5, 1878. *Siphonophora.*

For fuller description see Oestlund, Geol. and Nat. Hist. Surv. Minn., Bul. 4, p. 67, 1887.

Color.—All forms.—Brown, dark in apterae, lighter in alatae; cauda and legs white; cornicles black.

Measurements.—Apterous summer vivipara.—Body to base of cauda 1.4 to 2.3 mm.; hind tibiae .80 to 1.1 mm.; hind tarsi .11 to .13 mm.; antennae 1.4 to 1.8 mm.; III .28 to .43 mm.; IV .20 to .27 mm.; V .16 to .25 mm.; VI .10 to .11 + .45 to 65 mm.;* cornicles .25 to .40 mm.; cauda .14 mm. hard portion, .21 mm. entire length; rostrum obtuse, joint IV + V broad .11 mm., attaining or surpassing 2d. coxae. Alate vivipara.—Same as aptera except rostrum hardly attaining 2d. coxae.

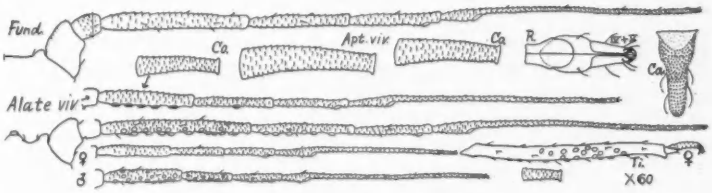


FIG. 164. *Aphis setariae.*

Structural Characters.—Vertex almost flat in apterae, distinctly convex in alatae. Frontal tubercles slightly developed, equalling vertex in alatae, exceeding vertex in apterae. Secondary sensoria circular, slightly convex, arranged in rather irregular row along almost entire length of joint, 15 to 21 on III, 3 to 7 on IV, 0 on V; absent in apterae. Hairs on vertex, antennae and tibiae .01 to .015 mm. long, pointed, fine and sparse. Cornicles slightly tapering, with indistinct flange, imbrications close and crenulate. Cauda slender, cylindrical, somewhat wider proximally, bearing 2 pairs of lateral hairs. Lateral tubercles present on prothorax and abdominal segments 1 to 5 and 6 and 7. Fore wings with 2d. fork of media about .33 the distance from margin of wing to 1st. fork. Hind wings with cubitus vestigial or absent. Oviparae with hind tibiae not noticeably swollen and bearing about 19 sensoria, mostly in middle portion. Males apterous.†

Collections.—On leaves and twigs of *Prunus domestica* as winter host; and *Echinochloa crusgalli* as summer host, at Ft. Collins, Boulder, Rocky Ford and Trinidad; fundatrices May 7, apterous summer viviparae May 24 to Oct. 21, alate viviparae June 13 to Oct. 21, sexuales Oct. 3 to Nov. 7; 40 collections, very common.

Taxonomy.—This species has been used as genotype for the genus *Hysteroneura* Davis, the distinguishing character

*A minority of individuals were found to have shorter measurements; antennae 1.07 to 1.4 mm.; III .18 to .25 mm.; IV .13 to .15 mm.; V .12 to .15 mm.; VI .09 + .41 to .50 mm.; III and IV often anastomosed; cornicles .15 to .23 mm.; body 1.2 mm. Alate with these have antennal III .25 to .30 mm. and sensoria 4 to 8 in one collection, 8 to 11 in another collection. No other differences are evident. Possibly further study may show these to be distinct.

†Four alate males were found with longer antennae, but otherwise structurally inseparable from this species.

being the absence of cubitus in the hind wings. This character varies from total absence to fragmentary traces. Furthermore, there seems to be no generic character whereby to classify apterae. In the opinion of the authors *Hysteroneura* should not be considered of generic rank.

Aphis solidaginifoliae Williams.

Williams, "Aphididae of Nebraska," Univ. Studies, Vol. 10, p. 58, 1910, and Davis, "Critical Rev.," Univ. Studies, Lincoln, Neb., Vol. 11, p. 20, 1911.

Color.—All forms.—Black to reddish or greenish-brown with black dashes on dorsum of all segments; shining; legs mostly yellowish; antennae somewhat dusky; cornicles and cauda dusky to black.

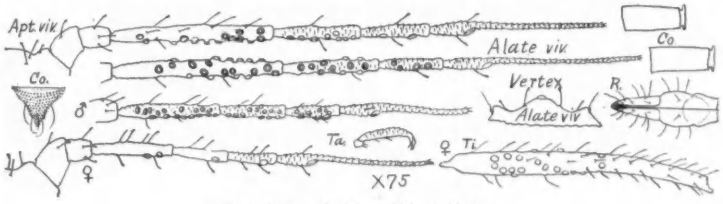


FIG. 165. *Aphis solidaginifoliae.*

Measurements.—Apterous summer vivipara.—Body 1.80 to 2 mm.; elongate oval; hind tibiae .70 to .75 mm.; hind tarsi .11 mm.; antennae 1 to 1.20 mm.; III .24 to .33 mm.; IV .14 to .18 mm.; V .12 to .14 mm.; VI .10 + .25 to .29 mm.; cornicles .12 to .16 mm.; cauda entire length .11 mm.; hard portion .08 mm. Alate vivipara.—Body 1.40 to 1.60 mm.; hind tibiae .75 to .80 mm.; hind tarsi .11 mm.; antennae 1.25 mm.; III .31 to .39 mm.; IV .18 to .20 mm.; V .12 to .14 mm.; VI .10 + .29 to .32 mm.; cornicles .13 mm.; cauda entire length .11 mm., hard portion .07 mm., rostrum obtuse, joint IV + V broad, .10 to .11 mm. long, attaining between 2d. and 3d. coxae.

Structural Characters.—Secondary sensoria round to oval, slightly tuberculate and strongly convex, scattered along entire length of joints, 20 to 24 on III, 10 to 13 on IV, 3 to 6 on V in alate viviparae; in apterous viviparae 7 to 15 on III, 5 to 11 on IV, 0 to 3 on V; in oviparae about 1 to 6 on distal half of III, usually 1 or 2 on IV. Hairs slightly capitate, at angle of 45 degrees, .03 to .05 mm. long on antennae, vertex and tibiae; pointed, curved and about .05 mm. long on cauda. Cornicles cylindrical with large flange, smooth. Cauda triangular, acute, broader than long, bearing two pairs of lateral hairs and a single dorsal hair. Lateral tubercles present on abdomen but shallow and difficult to observe. Mediae with 2d. fork about half the distance from margin of wing to 1st. fork. Males apterous.

Collections.—On folded leaves of *Solidago* sp. at Fort Collins; apterous summer viviparae July 16 to Sept. 26, alate viviparae

July 9 to Sept. 26 (scarce), oviparae Sept. 18 to Oct. 14, males Sept. 18 to 26; 16 collections, not rare.

Aphis spiraecola Patch.

Patch, Me. Agr. Exp. Sta. Bul. 233, p. 271, 1914, and Bul. 313, p. 56, 1923.

Color.—Viviparae.—Light greenish-yellow or yellowish-green to apple-green; head dusky in apterae; dusky on lateral areas and at bases of cornicles in alatae; antennae and legs mostly pale; cauda and cornicles black.

Measurements.—Apterous summer vivipara.—Body to base of cauda 1.20 to 1.70 mm.; hind tibiae .55 to .80 mm.; hind tarsi .11 mm.; antennae 1.10 to 1.13 mm.; III .17 to .28 mm.; IV .10 to .20 mm.; V .10 to .19 mm.; VI .09 to .12 + .16 to .28 mm.; cornicles .16 to .32 mm.; cauda entire length .17 to .20 mm., hard portion .12 to .14 mm. Alate vivipara.—Same as aptera except cornicles .12 to .28 mm. and cauda entire length .17 mm.; hard portion .10 mm.; rostrum obtuse, joint IV + V .095 mm. long, attaining between 2d. and 3d. coxae.

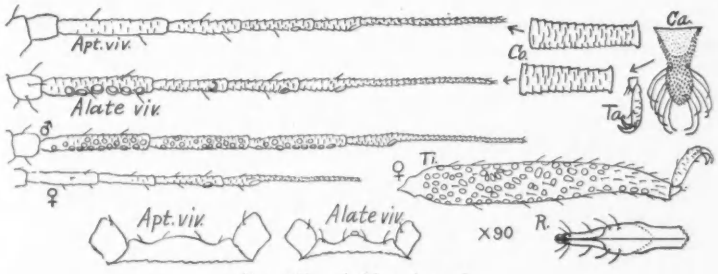


FIG. 166. *Aphis spiraecola.*

Structural Characters.—Secondary sensoria circular, as large as half of diameter of antennal joint, and nearly flat, arranged in single row along almost entire joint, 4 to 10 on III; 0 to 4 on IV, 0 on V; absent in apterae. Hairs pointed, drooping, .02 to .03 mm. long on antennae; .05 to .08 mm. long and curved on cauda. Cornicles cylindrical or slightly tapering, with slight flange and imbricated. Cauda elongate, cylindrical with slight neck, rather spoon-shaped and bearing 3 or 4 lateral and 3 dorsolateral hairs on each side. Lateral tubercles present. Mediae of fore wings with 2d. fork about .33 the distance from margin of wing to 1st. fork. Males alate. Oviparae about as large as apterous viviparae, with hind tibiae dusky, conspicuously swollen and closely covered with nearly flat sensoria.

Collections.—On leaves and twigs of *Spiraea* Van Houttei and *Spiraea* sp., *Helichrysum* sp. and *Viburnum Opulus* at Fort Collins and Denver; fundatrix April 21, apterous summer viviparae May 15 to Oct. 25, alate viviparae May 15 to Oct. 25,

oviparae Sept. 2 to Oct. 28, males Sept. 2 to Oct. 28; 17 collections, rather common.

Taxonomy.—This species has been considered as only a race of the same species as *Aphis pomi* De Geer (Patch, Jo. Ec. Ent., Vol. 22, 1929). In the viviparous forms the *Spiraea* aphid is distinguished from the apple aphid only by the smaller size and this character intergrades, but in the sexuales distinct differences occur. The alate form of the males and the dark colored, distinctly swollen closely sensoriated hind tibiae of the oviparae on *Spiraea* (Patch, Me. Agr. Exp. Sta., Bul. 313, p. 56, 1923) seem to the writers to clearly distinguish this form from *A. pomi.*

Aphis spiraephila Patch.

Patch, Me. Agr. Exp. Sta., Bul. 233, p. 270, 1914.

Color.—Viviparae and oviparae.—Hazel to chestnut-brown; cornicles and cauda dusky to black; legs and antennae mostly pale yellowish; body, especially in apterae, covered with powdery reticulations.

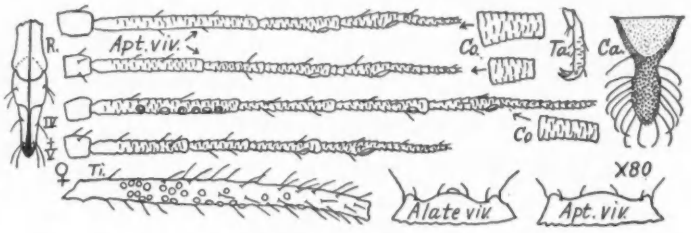


FIG. 167. *Aphis spiraephila.*

Measurements.—Apterous summer vivipara.—Body 1.30 to 1.70 mm.; hind tibiae .63 to .78 mm.; hind tarsi .11 mm.; antennae .75 to 1 mm.; III .19 to .23 mm.; IV .12 to .14 mm.; V .13 to .16 mm.; VI .11 + .14 to .15 mm.; cornicles .09 to .10 mm.; cauda entire length .24 mm., hard portion .16 mm. Alate viviparae.—Body 1.60 to 1.75 mm.; hind tibiae .90 to 1 mm.; hind tarsi .12 mm.; antennae 1 to 1.15 mm.; III .25 to .33 mm.; IV .17 to .22 mm.; V .16 to .20 mm.; VI .13 + .15 to .17 mm.; cornicles .10 to .15 mm.; cauda .20 mm. entire length, .13 mm. hard portion; rostrum obtuse, joint IV + V rather broad .09 to .10 mm. long, by .045 to .05 mm. wide at base, hardly attaining 2d. coxae.

Structural Characters.—Secondary sensoria round, rather small, hardly half as large as diameter of antennal joint, arranged in single row along distal .75 of joint III, 5 to 8 in number, none on IV and V;

absent in apterae. Hairs pointed, drooping, .02 to .03 mm. long on antennae, .03 to .04 mm. on hind tibiae; .05 to .06 mm. and slightly curved on cauda. Cornicles cylindrical or slightly tapering, without evident flange, imbricated, sometimes slightly curved inwards. Cauda elongate, with slight neck, or spoon-shaped, bearing 3 or 4 lateral and 3 or 4 dorsolateral hairs on each side. Lateral tubercles present. Mediae of fore wings with 2d. fork .33 to .5 the distance from margin of wing to 1st. fork. Oviparae about same size as viviparae, with hind tibiae pale, hardly swollen and bearing scattered, rather large, convex sensoria along most of length, but mostly on proximal half.

Collections.—On leaves and twigs of *Spiraea* sp. at Greeley; fundatrices May 7, apterous summer viviparae June 9 to Oct. 2; alate viviparae June 9 to Aug. 12; oviparae Oct. 21; 6 collections, rare or confined to a rare species of *Spiraea*.

Taxonomy.—This species differs from the original description of *Aphis spiraephila* Patch in the color which is given by Patch as "black," but since no structural differences were found it seemed best to place it here.

Aphis tetrapteralis Cockerell.

Cockerell, Bul. So. Calif. Ac. Sci., Vol. 1, No. 4.

Color.—Viviparae.—Grayish-green; cauda and antennae dusky; cornicles and legs pale.

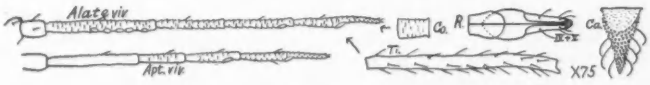


FIG. 168. *Aphis tetrapteralis.*

Measurements.—Apterous summer vivipara.—Body 1 mm.; hind tibiae .45 to .60 mm.; hind tarsi .10 mm.; antennae .55 to .60 mm.; III .14 to .17 mm.; IV .08 to .10 mm.; V .09 to .12 mm.; VI .08 to .10 + .06 mm.; cornicles .06 mm.; cauda .08 to .09 mm. hard portion, .10 to .13 mm. entire length; rostrum obtuse, joint IV + V .10 mm. long by .05 mm. at base, attaining abdomen. Alate vivipara.—Same as aptera except the following; antennae .70 mm.; III .22 mm.; IV .12 mm.; V .12 mm.; VI .10 + .06 mm.

Structural Characters.—Secondary sensoria circular, arranged in single row, grouped in twos, 5 or 6 on III in alate vivipara, absent on IV and V and in aptera. Hairs pointed, inconspicuous, .01 to .02 on vertex, antennae and outer side of hind tibiae; on cauda .05 mm. and curved, cornicles cylindrical, slightly stouter than hind tibiae, with slight flange and slightly imbricated. Cauda acute-conical, longer than wide, bearing 4 pairs of hairs. Fore wings with 2d. fork of media hardly .5 the distance from margin of wing to 1st. fork. Sexuales unknown.

Collections.—On leaves of *Atriplex* sp. at Colorado Springs; alate and apterous viviparae Aug. 30; 1 collection, rare, probably on account of scarcity of hosts where collecting has been done.

Aphis tulipae (Boyer).

Boyer Fonscolombe, Ann. Ent. Soc. Fr., Vol. 10, p. 167, 1841. *Aphis.*

Color.—Not recorded before mounting.

Measurements.—Apterous summer vivipara.—Body 1.90 mm.; hind tibiae .75 to .85 mm.; hind tarsi .12 to .13 mm.; antennae 1 mm.; III .25 to .30 mm.; IV .15 mm.; V .10 to .12 mm.; VI .08 + .25 mm.; cornicles .15 to .17 mm.; cauda .10 mm. entire length, .06 mm. hard portion. Alate vivipara.—Body 1.50 to 1.70 mm.; hind tibiae .90 mm.; hind tarsi .12 mm.; antennae 1.20 to 1.30 mm.; III .37 to .41 mm.; IV .19 to .22 mm.; V .14 mm.; VI .09 + .32 to .37 mm.; cornicles .12 to .14 mm.; cauda .10 mm. entire length, .06 mm. hard portion; rostrum obtuse, joint IV + V .13 to .14 mm. long, attaining between 2d. and 3d. coxae.

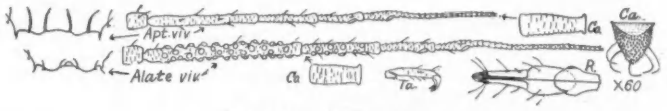


FIG. 169. *Aphis tulipae.*

Structural Characters.—Secondary sensoria on antennae circular tuberculate, scattered along entire length of joints, 36 to 41 in number on III, 4 to 11 on IV, 0 on V; absent in apterous viviparae. Hairs pointed, drooping, .02 to .03 mm. long on antennae and tibiae and on vertex of alatae, .05 mm. on vertex of apterous viviparae; .09 mm. long on cauda and curved. Cornicles cylindrical, with distinct flange and but faintly imbricated. Cauda conical, about as broad as long and bearing 2 pairs of lateral hairs and a single median hair at tip. Lateral tubercles developed. A pair of dorsolateral tubercles on 7th. and 8th. abdominal segments, and on occiput of head. Mediae of fore wings with 2d. fork between .33 to .5 the distance from margin of wing to 1st. fork.

Collections.—On bulbs of *Gladiolus* and roots of carrots at Boulder and Denver; alate and apterous viviparae April 7, 1926; one collection, rare.

Taxonomy.—This is the species described by Felt as *Aphis gladioli* (Felt, 24th. Rept. St. Ent. Inj. Ins. N. Y., Mus. Bul. 134, p. 19, 1909).

Aphis valerianae Cowen.

Gillette and Baker, Colo. Agr. Exp. Sta., Bul. 31, p. 121, 1895.

Color.—Viviparae.—Blackish-green to greenish-black; cauda and cornicles black; legs and antennae brownish to dusky. Nymphs with wing pads, tessellated on abdomen.

Measurements.—Apterous summer vivipara.—Body to base of cauda 2 to 2.50 mm.; hind tibiae .80 to 1 mm.; hind tarsi .14 mm.; antennae 1 to 1.35 mm.; III .33 to .35 mm.; IV .17 to .20 mm.; V .15 to .19 mm.; VI .10 + .17 to .19 mm.; cornicles .21 to .25 mm.; cauda .18 mm. entire length, .10 mm. hard portion. Alate vivipara.—Body to base of cauda 1.65 to 2 mm.; hind tibiae 1 mm.; hind tarsi .14 mm.; antennae 1.30 to 1.65 mm.; III .38 to .47 mm.; IV .22 to .36 mm.; V .18 to .24 mm.; VI .10 to .12 + .20 to .33 mm.; cornicles .14 to .20 mm.; cauda .17 mm. entire length, .10 mm. hard portion; rostrum obtuse, joint IV + V .12 mm. long, attaining between 2d. and 3d. coxae.

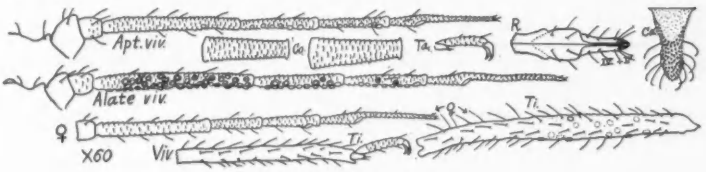


FIG. 170. *Aphis valerianae.*

Structural Characters.—Secondary sensoria round, small, hardly half as wide as antennal joint, convex and tuberculate, scattered over entire joint, 22 to 42 on III, 0 to 16 on IV, 0 to 14 on V in alate viviparae; in apterae 0 to 5 on III, 0 to 7 on IV, 0 to 6 on V. Hairs pointed, at angle of 30 to 50 degrees, not numerous, .02 to .03 mm. long on antennae, .03 to .04 mm. on vertex; .05 to .07 mm. and curved on cauda. Cornicles cylindrical or slightly tapering, with flange and with imbrications slightly setulose. Cauda cylindrical, obtuse, with but slight tendency to constriction, bearing 4 or 5 hairs on a side. Lateral tubercles present on prothorax and 1st. and 7th. abdominal segments. Mediae of fore wings .33 to .5 the distance from margin of wing to first fork. Males alate. Oviparae with hind tibiae slightly swollen and bearing about 10 faint sensoria.

Collections.—On leaves and stems of *Valeriana ceratophylla, edulis* and *trachycarpa* at Log Cabin, Cherokee Park, Pingree Park, Grand Mesa, Gunnison, Lost Lake at Crystal Mt., Steamboat Springs and Fort Collins; apterous summer viviparae June 30 to Sept. 6, alate viviparae June 30 to Sept. 26, oviparae Sept. 6, males Sept. 26; 11 collections, not rare.

Aphis varians Patch.

Patch, Me. Agr. Exp. Sta., Bul. 225, p. 50, 1914.

Characters.—Same as given for *A. neomexicana* Cockerell excepting secondary sensoria on antennae of alate viviparae which are as follows: 13 to 22 on III; 5 to 8 on IV; 0 to 4 on V. Mediae of fore wings with 2d. fork from .33 to over .5 the distance from margin of wing to 1st. fork.

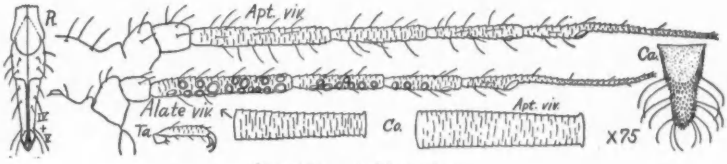


FIG. 171. *Aphis varians.*

Collections.—In curled leaves of *Ribes longiflorum* at Fort Collins; apterous summer viviparae May 26 to June 29, alate viviparae May 26 to July 25; 10 collections, not very common.

Taxonomy.—This species differs slightly from the original description of *A. varians* in the slightly smaller number of sensoria in the antennae of alate viviparae. Perhaps the Colorado form should be considered a distinct species or a variety of *A. neomexicana* or it may be *A. oenotherae.* The resemblance to *Aphis oenotherae* Oestlund is very close. However, the cornicle in *A. oenotherae* is usually shorter than the unguis while in *A. varians* cornicle is usually longer than unguis. The difference of host makes it seem best not to pronounce the two forms as identical without experimental biological work. The description of *Aphis grossulariae* Kaltenbach agrees in all particulars mentioned except Kaltenbach's statement that "cornicles are one-half to two-thirds normal length."

Aphis viburnicola Gillette.

Gillette, Ent. News, Vol. 20, p. 280, 1909.

Color.—Fundatrices whitish to pale green; powdery; oviparae whitish to reddish; alatae pale to reddish-brown with dusky cross bands which may be coalesced posterior to 2d. abdominal segment; appendages dusky to blackish, except in oviparae.

Measurements.—Fundatrix.—Body 2.50 mm. by 1.5 mm.; hind tibiae .90 mm.; antennae .90 mm.; III .37 mm.; IV .11 mm.; V .09 + .16 mm.; cornicles .18 mm.; cauda .07 to .08 mm. Alate vivipara.—Body 2.5 to 2.7 mm.; hind tibiae 1.25 mm.; hind tarsi .13 mm.; antennae 1.2 to 1.6 mm.; III .39 to .48 mm.; IV .18 to .22 mm.; V .17 to .20 mm.; VI .09 + .30 to .48 mm.; cornicles .20 mm.; cauda .10 mm. entire

length, .07 mm. hard portion; rostrum obtuse, joint IV + V .14 to .17 mm., barely attaining 3d. coxae.

Structural Characters.—Antennae rather stout, as wide or wider than hind tibiae in alatae; base of unguis abruptly constricted to unguis. Secondary sensoria large, subcircular, tuberculate, scattered over entire length of joints III, IV and V, 16 to 28 on III, 2 to 8 on IV, 1 to 3 on V in alate viviparae; absent in fundatrices and oviparae. Hairs pointed, rather drooping; numerous; on vertex .03 mm. long; on antennae .02 to .025 mm.; on outer side of hind tibiae .03 to .04 mm., shorter than width of tibiae; on cauda .06 mm. and curved. Cornicles cylindrical or slightly tapering, with flange and with setulose imbrications. Cauda conical, acute, about as broad as long and bearing 3 hairs on each side. Hind tibiae of spring migrants swollen on distal half and bearing about 20 sensoria, hind tibiae of fall migrants and fundatrices

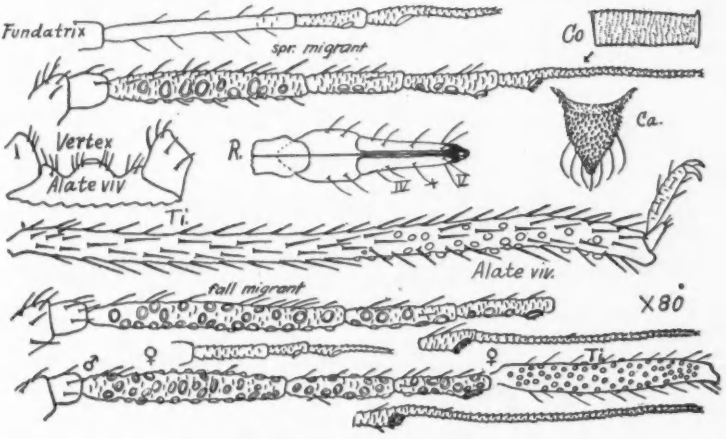


FIG. 172. *Aphis viburnicola.*

not noticeably swollen but bearing a few sensoria. Lateral tubercles distinct. A pair of dorsal tubercles present on abdominal segment 8. Mediae of fore wings with 2d. fork from .33 to .6 the distance from margin of wing to 1st. fork. Males alate. Oviparae with hind tibiae distinctly swollen along entire length and bearing numerous sensoria.

Collections.—On leaves of *Viburnum Opulus*, causing curling in spring, (Summer host unknown) at Fort Collins and Boulder; fundatrices April 1 to May 24, spring migrants May 14 to June 9, fall migrants Sept. 2 to Nov. 3, sexuales Sept. 7 to Nov. 5; 59 collections, quite common.

Types in U. S. Nat. Mus., Cat. No. 42814; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species is declared to be distinct from *Ceruraphis viburnicola* Borner (Mitt. a.d. Kais. Biol. Anst. H. 16, p. 34, 1916) or *virburniana* C. F. by Franssen ("*Aphis fabae* Scop." p. 55 and 56, 1927) after examination of material sent by Gillette. Neither can it be considered a synonym of *eriophori* Walker (Ann. Nat. Hist., Vol. 2, p. 46, 1848) according to description by Theobald (Aphid. Gr. Brit., Vol. 2, p. 69, 1927) who had access to some of Walker's material.

Aphis viburniphila Patch.

Patch, Jour. Ec. Ent., Vol. 10, p. 416, 1917.

Color.—Viviparae.—Reddish-brown mottled with paler color; apterae with dusky lateral areas and dorsal bands posterior to cornicles; alate viviparae with dusky on dorsal dashes and lateral areas, sometimes dusky bands lacking anterior to cornicles; cornicles black; legs yellow to black.

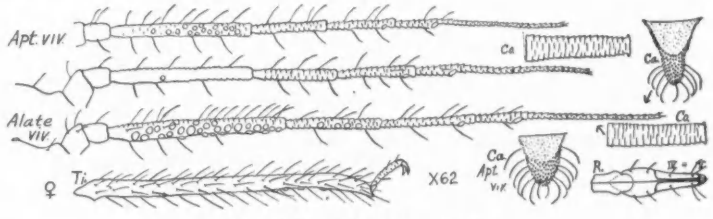


FIG. 173. *Aphis viburniphila.*

Measurements.—Apterous vivipara.—Body to base of cauda 2 mm.; hind tibiae .95 mm.; hind tarsi .12 mm.; antennae 1.1 to 1.3 mm.; III .32 to .36 mm.; IV .19 to .20 mm.; V .17 to .19 mm.; VI .10 + .28 to .32 mm.; cornicles .14 to .27 mm.; cauda .05 to .06 mm. on hard portion, .12 mm. entire length. Alate vivipara.—Body to base of cauda 2 mm.; hind tibiae 1 mm.; hind tarsi .11 mm.; antennae 1.3 mm.; III .37 to .44 mm.; IV .22 to .24 mm.; V .19 to .24 mm.; VI .09 to .12 + .32 mm.; cornicles .19 to .24 mm.; cauda .05 mm. hard portion; rostrum obtuse, joint IV + V .12 mm., attaining between 2d. and 3d. coxae.

Structural Characters.—Secondary sensoria circular, 20 to 28 on antennal joint III and 5 to 7 on joint IV in alate viviparae; 0 to 20 on joint III in apterous viviparae; absent in oviparae. Cornicles cylindrical, with flange and imbrications, smooth. Cauda obtuse without constriction, short cylindrical to broader basally, not longer than broad, bearing about 4 pairs of lateral and 3 pairs of dorsolateral hairs, bushy. Lateral tubercles present. Mediae of fore wings with 2d. fork from nearly .33 to nearly .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae not swollen and bearing about 4 flat sensoria on distal third. Males apterous.

Collections.—On leaves and stems of *Viburnum Opulus* in Fort Collins, Boulder and Denver; apterous viviparae May 24 to Oct. 25, alate viviparae May 24 to Oct. 17, sexuales Oct. 14; 14 collections, rather common.

Taxonomy.—This species differs from description of *A. viburniphila* Patch in the long hairs which were neither mentioned nor figured. However, as they are much less noticeable in balsam they might have been overlooked. In the character of hairs this form agrees with *Aphis lantanae* Koch, but differs in color, cornicles and sensoria in apterous viviparae. *Aphis hederae* Kalt. is distinguished by antennal hairs which are shorter, fewer in number and more drooping; also by the constricted cauda.

Genus **Asiphonaphis** Wilson and Davis.

Wilson and Davis, Ent. News, Vol. 30, p. 39, 1919.

Characters.—Cornicles absent. Otherwise same as genus *Aphis*.

Genotype **Asiphonaphis pruni** Wilson and Davis.

Wilson and Davis, Ent. News, Vol. 30, p. 39, 1919.

Color.—All forms.—Pale yellowish or whitish-green, with intersegmental lines bluish-green, broader on median line, sometimes coalescing to form median line of green; appendages pale brownish. Wing venation not noticeably dusky.

FIG. 174. *Asiphonaphis pruni.*

Measurements.—Apterous summer vivipara.—Body 1.60 to 2.40 mm.; hind tibiae .80 to .85 mm.; hind tarsi .13 mm.; antennae 1 to 1.2 mm.; III .27 to .32 mm.; IV .15 to .21 mm.; V .17 to .20 mm.; VI .12 to .13 + .32 to .35 mm.; cauda .10 mm. hard portion, .15 mm. entire length; rostrum rather broadly obtuse, joint IV + V .15 mm. long, attaining halfway between 1st. and 2d. coxae. Alate vivipara.—Body 1.8 to 2 mm.; hind tibiae .90 to 1 mm.; hind tarsi .14 mm.; antennae 1.2 to 1.4 mm.; III .28 to .38 mm.; IV .20 to .26 mm.; V .16 to .21 mm.; VI .11 to .14 + .35 to .40 mm.; cauda and rostrum as in apterae.

Structural Characters.—Vertex slightly convex. Frontal tubercles not exceeding vertex. Secondary sensoria circular, arranged in irregular partly double row along entire joint, 13 to 20 on III, 2 to 6 on IV, 0 on V; absent in apterae. Hairs pointed; on vertex and antennae

.03 mm.; on tibiae .03 to .04 mm. and sparse. Cauda conical or cylindrical with slight constriction at middle, bearing two or three hairs on either side and a single dorsal one at tip. Lateral tubercles large and conspicuous on prothorax and abdominal segments 1, 2, 3, 4, 6 and 7. Fore wings with media twice forked, 2d. fork .25 to .5 the distance from margin of wing to 1st. fork; hind wings with media and cubitus. Oviparae with hind tibiae slightly swollen and bearing numerous small sensoria.

Collections.—On leaves of *Prunus melanocarpa* near Boulder, Estes Park, Bellvue and Fort Collins; fundatrices May 6, apterous summer viviparae May 13 to Sept. 15, alate viviparae May 25 to Aug. 11, oviparae Oct. 11, males not taken; 12 collections, not rare.

Taxonomy.—This form differs from the original description of *Asiphonaphis pruni* in slightly shorter antennal joints, entire lack of sensoria on antennal joint V and lack of noticeable duskiness of wing venation. The host is a different species of *Prunus*. The differences seem to be of only varietal significance so the Colorado specimens are here placed under Wilson's and Davis' species.

Genus **Aspidaphis** Gillette.

Gillette, Can. Ent., Vol. 49, p. 196, 1917.

Characters.—Vertex strongly convex. Frontal tubercles distinctly produced, fully equal with vertex. Antennae 5-jointed. Secondary sensoria circular. Cornicles clavate, recumbent, without flange, and with opening placed laterally on inner side near distal end. Lateral tubercles absent. Hairs very inconspicuous. Eighth tergite forming triangular shield extending over cauda. Wing venation as in *Aphis*.

Genotype **Aspidaphis polygoni** Gillette.

[=*Aspidaphis adjuvans* (Walker). Walker, Zoologist, Vol. 6, p. 2220, 1848. *Aphis*. (See also Theobald, Aph. Gr. Brit., Vol. 2, p. 310).]
Gillette, Can. Ent., Vol. 49, p. 196, 1917.

Color.—Viviparae.—Pale yellow to pale bluish-green; all appendages pale.

Measurements.—Apterous vivipara.—Body 1.5 to 2 mm.; hind tibiae .35 to .50 mm.; hind tarsi .11 mm.; antennae .35 to .50 mm.; III .13 to .17 mm.; IV .07 to .09 mm.; V .07 + .07 mm.; cornicles .08 mm.; cauda .08 mm. hard portion, .11 mm. entire length. Alate vivipara.—Body 1.4 to 2 mm.; hind tibiae .55 mm.; hind tarsi .12 mm.; antennae .58 to .85 mm.; III .18 to .28 mm.; IV .08 to .15 mm.; V .07 to .11 + .08 to .13 mm.; cornicles .07 mm.; cauda .09 mm. hard portion, .11 mm. entire length. Rostrum broadly obtuse, joint IV + V .05 to .07 mm. long, attaining between 1st. and 2d. coxae.

Structural Characters.—Secondary sensoria circular, arranged in single row along entire length of joint III, 6 to 8 in number in alate vivipara; absent on other joints and in apterae. Hairs blunt, minute and sparse. Body surface especially in apterae, rugose. Cornicles clavate, without flange, with opening on inner side slightly before tip, smooth, recumbent against body, weak, hardly wider than joint III of antennae. Cauda conical, acute, bearing 3 straight hairs .02 mm. long on each side. Lateral tubercles absent. Wing venation as in

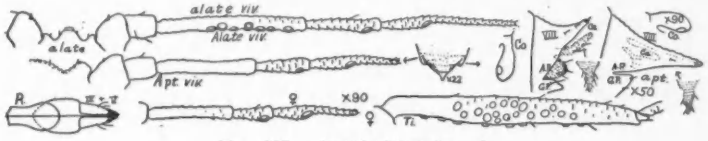


FIG. 175. *Aspidaphis polygoni.*

genus *Aphis*. Oviparae with hind tibiae moderately swollen along middle and bearing 20 or more large, circular, rather flat sensoria. Male unknown to us.

Collections.—On under side of leaves of *Polygonum aviculare* at Fort Collins and Boulder; apterous summer viviparae April 27 to Oct. 10, alate viviparae June 19 to Aug. 4, oviparae Oct. 6; 21 collections, common.

Types in U. S. Nat. Mus., Cat. No. 41931; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—Aspidaphis polygoni Gillette was considered very close to *Aspidaphis adjuvans* Walker by Laing (Ent. Mo. Mag., 3d. Ser., Vol. 7, p. 126, 1921). After examination of examples of Gillette's species sent him by us, Laing writes that there seems to be no valid reason why the two species should not be the same. We accordingly give *A. polygoni* Gillette as a synonym of *Aspidaphis adjuvans* Walker.

Aspidaphis aquatica (Gillette and Bragg).

Gillette and Bragg, Ent. News, Vol. 27, p. 447. *Siphocoryne.*

Color.—Viviparae.—Light yellowish-green; alatae with dusky band and blotches on most of abdominal segments, often coalesced into a dorsal patch on segments 2, 3, 4 and 5; apterae heavily powdered ventrally; cornicles and legs pale; cauda pale or dusky to blackish; legs appearing powdery.

Measurements.—Apterous summer vivipara.—Body 2.60 by .7 to 1 mm.; hind tibiae .85 to .90 mm.; hind tarsi .17 mm.; antennae .85 to .95 mm.; III .27 to .30 mm.; IV .11 to .15 mm.; V .11 to .12 mm.; VI .11 to .14 + .12 to .13 mm.; cornicles .25 to .30 mm.; cauda .15 mm.

on hard portion, .20 mm. entire length; rostrum obtuse, joint IV + V rather broad, .09 mm. long, barely attaining 2d. coxae. Alate viviparа.—Body, to base of cauda, 2 mm.; hind tibiae .9 to 1 mm.; hind tarsi .18 mm.; antennae 1.10 mm.; III .33 to .38 mm.; IV .16 to .20 mm.; V .14 to .18 mm.; VI .11 to .18 + .13 to .16 mm.; cornicles .18 to .23 mm.; cauda as in apterae; rostrum attaining between 1st. and 2d. coxae.

Structural Characters.—Vertex slightly to strongly convex. Frontal tubercles not exceeding vertex. Dorsum of apterae rugose. Secondary sensoria circular, irregular in size, some larger than half diameter of antennal joint, about 14 on III in alate viviparae, 0 on IV, 0 on V; 0 to 4 faint ones on III in apterae. Hairs blunt or slightly capitate;

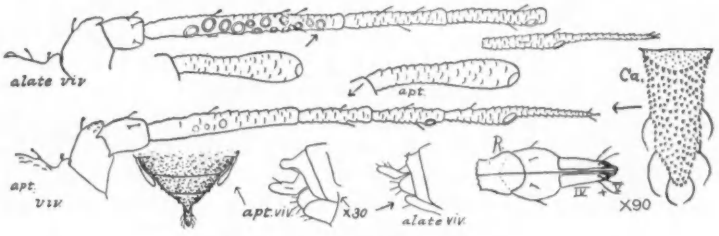


FIG. 176. *Aspidaphis aquatica.*

on vertex and antennae .01 to .015 mm. on hind tibiae .01 to .015 mm. on outer side in alatae, .02 mm. in apterae; on cauda .05 mm. and curved; apparently absent on body in apterae. Cornicles clavate without flanges and with opening mostly on inner side of tip, faintly imbricated, weak and held against body, recumbent. Cauda parallel-sided to long-conical, bearing 3 pairs of lateral hairs. Eighth abdominal segment with dorsal tubercle, wart-like in alatae but nearly as long as hard portion of cauda in apterae and rather triangular and shield-shaped. Fore wings with mediae twice branched and with 2d. fork about .5 the distance from margin of wing to 1st. fork.

Collections.—On leaves and stems of *Catabrosa aquatica* often beneath the surface of the water at Fort Collins and Denver; alate and apterous viviparae all months of the year, sexuales unknown; 40 collections, common.

Genus **Atarsos** Gillette.

Gillette, Ent. News, Vol. 22, p. 440, 1911.

Characters.—Frontal tubercles rudimentary. Secondary sensoria circular. Hairs capitate. Tarsi entirely lacking. Cornicles cylindrical. Cauda conical. Fore wings with mediae twice-branded; hind wings with both media and cubitus.

Genotype **Atarsos grindeliae** Gillette.

Gillette, Ent. News, Vol. 22, p. 440, 1911.

Color.—All forms.—Pale yellow to pale green, alatae with faint broken dusky dashes and lateral areas; appendages pale to dusky. Venation rather heavy.

Measurements.—Apterous summer vivipara.—Body 1.05 mm.; hind tibiae .50 to .72 mm.; antennae .72 to 1.05 mm.; III .19 to .29 mm.; IV .08 to .11 mm.; V .07 to .09 mm.; VI .08 + .09 to .12 mm.; cornicles .15 mm.; cauda .06 mm. hard portion, .07 mm. entire length; rostrum slender, obtuse, joint IV + V .10 mm., attaining between 2d. and 3d. coxae. Alate vivipara.—Body 1.6 to 2 mm.; hind tibiae .80 mm.; antennae 1.12 mm.; III .40 to .50 mm.; IV .18 to .20 mm.; V .13 to .16 mm.; VI .09 + .13 mm.; cornicles .15 mm.; rostrum hardly attaining 2d. coxae.

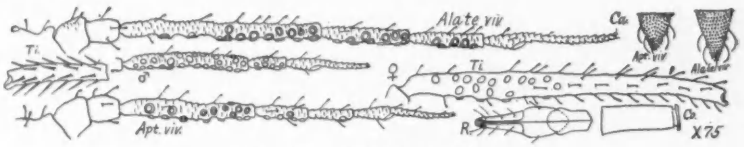


FIG. 177. *Atarsos grindeliae.*

Structural Characters.—Secondary sensoria circular, tuberculate, scattered, in alate viviparae 21 on III, 10 on IV, 5 on V; in apterous vivipara 5 to 9 on III, 4 on IV and 1 to 2 on V. Hairs capitate, .02 to .03 mm. on vertex and antennae; .03 to .04 mm. on outer side of hind tibiae. Cornicles cylindrical, with distinct flange and with collar-like depression just before flange, smooth. Cauda conical, hardly longer than broad, bearing two pairs of hairs on each side and one on top of tip. Tarsi entirely missing. Fore wings with 2d. fork of media from .33 to .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae slightly swollen on basal half and bearing about 18 rather large sensoria. Males apterous.

Collections.—On leaves of *Grindelia squarrosa, Machaeranthera viscosa* and *Aster* sp. at Fort Collins; fundatrices April 16 to May 11, apterous summer viviparae April 26 to Aug. 22, alate viviparae May 3 to June 23, sexuales Sept. 29 to Oct. 24; 25 collections, rather common.

Types in U. S. Nat. Mus., Cat. No. 41932; paratypes in collection of Colo. Agr. Exp. Sta.

Genus **Brachycolus** Buckton.

Buckton, Brit. Aphid., Vol. 2, p. 146, 1879.

Characters.—Body long and narrow. Cornicles hardly more than pores. Vertex rather flat. Frontal tubercles not developed. Antennae 6-jointed. Legs short; tarsi rather long. Radial sector but slightly curved. Hairs pointed and inconspicuous.

Genotype, *Aphis stellariae* Hardy. (See below.)

KEY TO SPECIES OF BRACHYCOLUS.

A. Rostrum with joint IV + V .07 mm. long, not attaining 2d. coxae. (Page 460) ..... **stellariae**

AA. Rostrum with joint IV + V .12 mm. long, surpassing 2d. coxae. (Page 461) ..... **tritici**

Genotype **Brachycolus stellariae** (Hardy).

Hardy, No. Brit. Agr., Vol. 2, p. 788, 1850. *Aphis.*

Color.—Viviparae.—Pale yellowish or greenish.

Measurements.—Apterous summer vivipara.—Body 1.8 mm.; hind tibiae .45 mm.; hind tarsi .13 mm.; antennae .63 mm.; III .17 mm.; IV .09 mm.; V .09 mm.; VI .09 + .12 mm.; cornicles .02 mm.; cauda .10 mm. hard portion, .13 mm. entire length; rostrum rather stout, obtuse, joint IV + V .07 mm. long, hardly attaining 2d. coxae. Alate vivipara.—Body 1.3 mm.; hind tibiae .60 mm.; hind tarsi .15 mm.; antennae .70 to .80 mm.; III .19 to .22 mm.; IV .10 to .11 mm.; V .11 mm.; VI .09 to .10 + .12 to .16 mm.; cornicles, cauda and rostrum as in apterae.

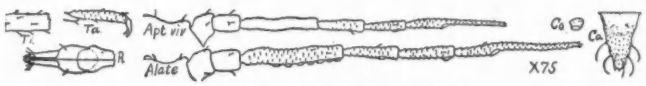


FIG. 178. *Brachycolus stellariae.*

Structural Characters.—Secondary sensoria circular, convex, arranged in a row on distal two-thirds of III 4 to 6, on IV 0 to 1, on V 0; absent in apterae. Hairs pointed, very sparse; on vertex and antennae .01 to .015 mm.; on tibiae .015 to .02 mm. Cornicles slightly raised, truncate, without flange. Cauda conical, rather blunt, 1.25 times as long as wide, bearing 2 hairs on each side and 1 or 2 on top of tip. Fore wings with 2d. fork of media .33 to .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae slightly swollen on basal half and bearing rather numerous sensoria.

Collections.—On "grass stem" at Fort Collins; apterous summer viviparae Aug. 19, alate viviparae May 31 and June 3, oviparae Nov. 20; 4 collections, apparently rare.

Taxonomy.—This species agrees with specimens kindly given us by P. Van der Goot and presumably determined by him.

Brachycolus tritici Gillette.

Gillette, Ent. News, Vol. 22, p. 441, 1911.

Color.—All forms.—Pale yellowish to pale green; slightly powdery; wing veins black.

Measurements.—Apterous summer vivipara.—Body 1.15 to 1.88 mm.; hind tibiae .43 to .55 mm.; hind tarsi .13 to .15 mm.; antennae .59 to .70 mm.; III .12 to .17 mm.; IV .07 to .09 mm.; V .07 to .09 mm.; VI .07 to .09 + .10 to .12 mm.; cornicles .01 mm. high; cauda .09 to .10 mm. hard portion, .13 to .15 mm. entire length; rostrum slender, obtuse, joint IV + V .12 mm. long, attaining 2d. coxae. Alate vivipara.—Body 1.3 to 1.5 mm.; hind tibiae .55 to .65 mm.; hind tarsi .13 to .15 mm.; antennae .70 to .80 mm.; III .17 to .20 mm.; IV .09 to .12 mm.; V .09 to .10 mm.; VI .08 + .12 to .13 mm.; cornicles, cauda and rostrum as in apterae.

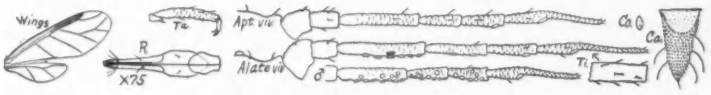


FIG. 179. *Brachycolus tritici.*

Structural Characters.—Secondary sensoria circular, arranged in irregular row, 4 to 8 on III, 2 on IV, 0 to 1 on V; absent in apterae. Hairs pointed .01 to .02 mm. long on vertex, antennae and tibiae, very sparse. Cornicles merely slightly raised pores. Cauda conical, acute, nearly twice as long as wide, bearing 2 or 3 hairs on each side and one on top of tip. Lateral tubercles not evident. Tarsi long and slender but 1st. joint triangular. Fore wings with 2d. fork of media .33 to .5 the distance from margin of wing to 1st. fork; radial sector nearly straight. Males apterous.

Collections.—On leaves of wheat and *Agropyron* sp. near Boulder and Fort Collins; apterous summer viviparae May 5 to Oct. 12, alate viviparae May 12 to July 18, sexuales Oct. 12; 15 collections, rather rare.

Types in U. S. Nat. Mus., Cat. No. 41934; paratypes in collection of Colo. Agr. Exp. Sta.

Genus **Braggia** Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 22, p. 28, 1929.

Characters.—Vertex slightly rounded. Frontal tubercles but slightly developed. Cornicles conical with wide flange. Cauda broadly semicircular resembling a body segment. Hairs on body heavy, cylindrical, blunt to capitate. Other characters as in genus *Aphis.*

Genotype **Braggia echinata** Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 22, p. 29, 1929.

Color.—Viviparae.—Medium to dark olive-green with white reticulations and white, capitate or heavy blunt hairs, giving a conspicuously frosted appearance, especially in apterae; legs mostly pale; cornicles dusky.

Measurements.—Apterous vivipara.—Body 1.87 mm.; hind tibiae .50 to .55 mm.; hind tarsi .09 mm.; antennae .70 mm.; III .15 to .21 mm.; IV .11 to .14 mm.; V .11 to .13 mm.; VI .08 + .07 mm.; cornicles .07 to .08 mm.; cauda .06 mm. hard portion, .08 mm. entire length. Alate vivipara.—Body 1.40 mm.; hind tibiae .47 to .60 mm.; antennae .75 mm.; III .24 to .28 mm.; IV .13 to .16 mm.; V .13 to .15 mm.; VI .09 to .11 + .06 to .08 mm.; cornicles .05 to .07 mm.; cauda .05 mm. hard portion, entire length .07 mm.; rostrum slender, obtuse, joint IV + V .12 to .13 mm. long, attaining between 2d. and 3d. coxae.

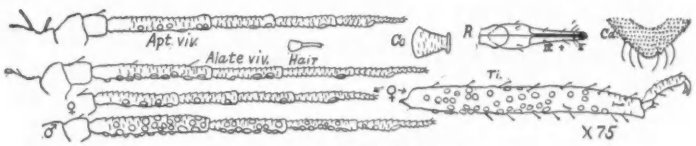


FIG. 180. *Braggia echinata.*

Structural Characters.—Frontal tubercles very slightly developed. Vertex slightly convex. Secondary sensoria round, slightly convex to flat, in alatae about half as large as diameter of antenna, arranged in single row, 8 to 12 on III, 3 on IV, 0 on V; in apterae variable in size, 2 to 6 on III, 0 to 2 on IV. Hairs heavy and blunt, resembling capitate hairs, most conspicuous in apterae and on posterior segments, .04 mm. long; on antennae very sparse and inconspicuous; on legs sparse and .01 to .02 mm. long; on cornicles pointed, curved, .03 to .04 mm. long. Cornicles conical truncated, with large flange, faintly imbricated. Cauda broadly semicircular, resembling a body segment, bearing 3 pairs of lateral hairs. Lateral tubercles present. Media of fore wings with 2d. fork about .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae blackish and moderately swollen for nearly entire length and bearing rather large flat sensoria scattered over most of tibiae. Males alate.

Collections.—On leaves and stems of *Eriogonum* sp. near Fort Collins; apterous summer viviparae June 7 to Oct. 7, alate viviparae July 8 to Oct. 17, sexuales Oct. 6 to 17; 13 collections, rather rare.

Types in U. S. Nat. Mus., Cat. No. 41468; paratypes in collection of Colo. Agr. Exp. Sta.

Genus **Brevicoryne** Van der Goot.

Van der Goot, Beitrage z. Kennt. d. Holl. Blattlause, p. 245, 1915.

Characters.—Vertex moderately convex. Frontal tubercles not distinctly exceeding vertex. Hairs pointed. Cornicles clavate, short, not distinctly longer than cauda. Cauda conical. Other characters as in *Rhopalosiphum.*

Genotype, *Aphis brassicae* Linnaeus. (See below.)

KEY TO SPECIES OF BREVICORYNE.

A. Antennal III at least as long as IV + V; secondary sensoria absent on IV and V in alate viviparae (Page 463).....**brassicae**
AA. Antennal III shorter than sum of IV + V; secondary sensoria on IV and V in alate viviparae. (Page 464).....**symphoricarpi**

Genotype **Brevicoryne brassicae** (Linnaeus).

Linnaeus, Syst. Nat. Ed. 10, Tom. I, p. 452, 1758. *Aphis.*

Color.—Viviparae.—Pale greenish with broken dashes of dusky; alatae with dusky lateral areas; apterae slightly powdery; cornicles and legs dusky.

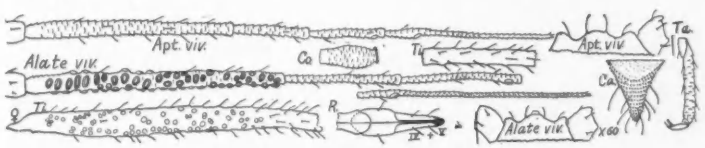


FIG. 181. *Brevicoryne brassicae.*

Measurements.—Apterous summer vivipara.—Body 1.8 to 2.15 mm.; hind tibiae 1.15 to 1.25 mm.; hind tarsi .20 mm.; antennae 1.2 to 1.9 mm.; III .37 to .60 mm.; IV .15 to .22 mm.; V .16 to .22 mm.; VI .11 to .12 + .28 to .32 mm.; cornicles .13 to .19 mm.; cauda .10 to .12 mm. hard portion, .16 mm. entire length; rostrum obtuse, joint IV + V .13 mm. long, barely attaining 2d. coxae. Alate vivipara.—Body 2 to 2.3 mm.; hind tibiae 1.4 mm.; hind tarsi .21 mm.; antennae 2 mm.; III .50 to .70 mm.; IV .25 to .30 mm.; V .26 to .30 mm.; VI .11 to .14 + .41 to .58 mm.; cornicles .11 to .15 mm.; cauda as in aptera; rostrum with joint IV + V .15 mm. long, not attaining 2d. coxae.

Structural Characters.—Vertex distinctly convex, exceeding frontal tubercles. Secondary sensoria circular to oval with distinct margins, somewhat tuberculate, scattered along entire length of III, about 50 in number in alate viviparae; absent in apterae. Hairs pointed, .02 to .04 mm. long on vertex, antennae and tibiae. Cornicles slightly swollen in middle, with small flange and faintly imbricated, slightly wider at middle than hind tibiae. Cauda conical, acute, bearing 2 pairs of lateral and one pair of dorsal hairs. Fore wings with 2d. fork of mediae about .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae moderately swollen and bearing small, rather sparsely scattered sensoria throughout almost entire length. Males alate.

Collections.—On cabbage, cauliflower and radishes generally throughout the state; fundatrices Feb. 3 to April 8, apterous and alate viviparae every month in the year, males Oct. 27 to Dec. 6, oviparae Nov. 13 to Feb. 21; 60 collections, common and injurious.

Brevicoryne symphoricarpi (Thomas).

Thomas, Ill. St. Lab. Nat. Hist., Bul. 2, p. 12, 1877. *Aphis.* (See also Hottes and Frison, Ill. Nat. Hist. Surv. Bul., Vol. 19, p. 438, 1930. *Aphis.*)

For fuller description see Oestlund, Geol. and Nat. Hist. Surv. Minn., Bul. 4, p. 52, 1887. *Aphis albipes.*

Color.—Fundatrices.—Medium or brownish-green; head and areas about cornicles brownish. Summer viviparae.—Young, pale yellow; adult black or dusky green with black cross bands in alatae and powdery cross dashes in apterae on abdominal segments 1, 4, 5, 7 and 8. Sexuales pale greenish to rusty-yellowish; male with dusky cross markings, oviparae with white markings as in apterae; legs pale in all forms.

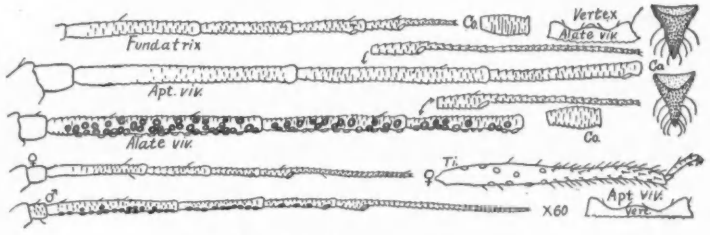


FIG. 182. *Brevicoryne symphoricarpi.*

Measurements.—Apterous vivipara.—Body to base of cauda 2 to 2.8 mm.*; hind tibiae 1.2 mm.; antennae 2.4 mm.; III .54 to .64 mm.; IV .41 to .56 mm.; V .37 to .45 mm.; VI .13 + .46 to .65 mm.; cornicles .11 to .16 mm.; cauda .11 to .14 mm. Alate vivipara.—Body to base of cauda 1.5 to 2 mm.; hind tibiae 1.2 mm.; antennae 1.6 to 2 mm.; III .51 to .64 mm.; IV .33 to .45 mm.; V .25 to .31 mm.; VI .11 to .14 + .40 to .46 mm.; cornicles .11 to .15 mm.; cauda .11 to .14 mm.; rostrum obtuse, joint IV + V .13 mm.; attaining 2d. coxae in apterae, hardly in alatae. Oviparae.—Body 1 to 1.25 mm.

Structural Characters.—Secondary sensoria round, tuberculate, with broad margins, scattered over entire length of joints III, IV and V in alatae, 38 to 55 on III, 26 to 31 on IV, 8 to 14 on V; absent in apterae. Hairs on antennae sparse and inconspicuous. Cornicles cylindrical, or slightly curved with constricted base; imbricated. Cauda elongate-conical with but slight tendency to constriction near base, bearing 4 or 5 hairs on each side. Lateral tubercles well developed. Dorsal integument reticulated. Oviparae with proximal .5 of hind tibiae swollen

*One collection of over 12 apterous viviparae taken August 31, measure only 1 mm. No difference in structural characters can be detected.

and bearing about 6 large, circular, flat sensoria; 2 to 5 eggs apparent through body wall. Male apterous.

Collections.—On *Symphoricarpos occidentalis*, curling leaves, in foothills near Fort Collins, LaPorte, Bellvue, Boulder and Colorado Springs; fundatrix May 13, summer apterous viviparae May 13 to Sept. 23, alate viviparae May 13 to July 1, sexuales Sept. 23 to Oct. 11; 26 collections, fairly common.

Taxonomy.—This species is the genotype of *Thargelia* Oestlund (19th. Rept. St. Ent. Minn., p. 127, 1922). The characters, however, in the opinion of the authors, are congeneric with *Brevicoryne brassicae*. L.

Genus **Cavariella** Del Guercio.

Del Guercio, Redia, Vol. 7, p. 323, 1911.

Characters.—Vertex convex. Frontal tubercles indistinct. Antennae 6-jointed, bearing prominent circular sensoria in alatae. Cauda conical. Abdomen with supra-caudal process on eighth segment, most prominent in apterae. Venation as in genus *Rhopalosiphum*.

Genotype, *Aphis pastinacae* Linnaeus. (See below.)

KEY TO SPECIES OF CAVARIELLA.

A. Cornicles distinctly clavate.
  B. Supra-caudal process in apterae knob-like, much shorter than cauda. Unguis 1.5 times base or longer (Page 465)..... **pastinacae**
  BB. Supra-caudal process in apterae triangular, as long as cauda. Unguis shorter than 1.5 times base. (Page 466)..... **capreae**
AA. Cornicles cylindrical, hardly clavate. (Page 468)..... **theobaldi**

[Genotype **Cavariella pastinacae** (Linnaeus).]

Linnaeus, Syst. Nat., Ed. 10, p. 451, 1758. *Aphis* (name and host); Fauna Suecica, Ed. Alt., p. 259, 1761; *Aphis* (Description) and Syst. Nat., I, p. 734, 1767.

For fuller description see Theobald, Aph. Gr. Brit., Vol. 2, p. 13, 1927.

Color.—Viviparae.—Green to yellowish-green; alatae with dusky bands; appendages pale to dusky.

Measurements.—Apterous summer vivipara.—Body 1.8 to 2.5 mm.; antennae not reaching 2d. coxae or about .33 of body; III longest, not quite as long as IV + V + VI; IV less than .33 of III, a little longer than V; VI equal to IV + V; base of VI equal to V, a little longer than IV; unguis 1.5 times base, equal to IV + V + base; rostrum attaining to or past 2d. coxae; cornicles nearly equal to III + IV; cauda half as long as cornicles; legs short and thick. Alate vivipara.—Body 2.5 mm.; antennal III much the longest; IV and V nearly equal; base of VI not .5 of V; unguis as long as IV + V + base; cornicles twice as long as cauda, .66 length of III.

Structural Characters.—Secondary sensoria markedly tuberculate, thick along entire length of III. Cornicles clavate. Supra-caudal process prominent but small, knob-like, bearing 2 apical hairs. Cauda thick, bearing 3 hairs on each side. Body surface of apterae shagreened.

Hosts.—*Salix* sp., *Pastinaca sativa, Daucus Carota* and many wild *Umbelliferae.*

(Description written from data by Theobald). Not recorded from the state.

Cavariella capreae (Fabricius).

Fabricius, Syst. Ent., p. 734, 1775. *Aphis.*

For fuller description see Theobald, Aph. Gr. Brit., Vol. 2, p. 5, 1927. Also Gillette, Jour. Ec. Ent., Vol. 4, p. 320, 1911. *Rhopalosiphum.*

Color.—Viviparae.—Pale green; cornicles, cauda and legs pale to slightly dusky. Sexuales.—Brownish to reddish.

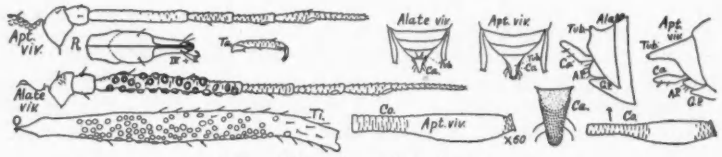


FIG. 183. *Cavariella capreae.*

Measurements.—Apterous summer vivipara.—Body 1.85 to 2.15 mm.; dorsal tubercle extending .10 mm. beyond 8th. segment; hind tibiae .70 to .85 mm.; hind tarsi .14 mm.; antennae .82 to .95 mm.; III .20 to .30 mm.; IV .10 to .12 mm.; V .10 to .12 mm.; VI .11 to .13 + .13 to .15 mm.; cornicles .40 to .48 mm.; cauda .11 mm. hard portion, .15 mm. entire length; rostrum obtuse, joint IV + V .11 mm. attaining 2d. coxae; dorsal tubercle not projecting beyond 8th. segment. Alate vivipara.—Body 1.2 to 2 mm.; hind tibiae .80 to .95 mm.; hind tarsi .13 mm.; antennae 1 to 1.10 mm.; III .33 to .40 mm.; IV .14 to .17 mm.; V .14 to .17 mm.; VI .13 to .15 + .18 to .20 mm.; cornicles .30 to .38 mm.; cauda .10 to .14 mm.; hard portion, .19 mm. entire length.

Structural Characters.—Vertex distinctly convex. Frontal tubercles evident but not attaining vertex. Body surface in apterae shagreened or punctate. Secondary sensoria circular, rather tuberculate, 14 to 20 scattered along entire length of III in alate viviparae; absent in apterae. Hairs blunt, sparse; on vertex and antennae .01 to .015 mm.; on tibiae .01 mm. on outside, .02 mm. on inner side. Cornicles clavate, at middle wider than tibiae, transversely rugose proximally, faintly imbricated distally, with flange somewhat oblique. Dorsal tubercle blunt bearing 2 hairs at tip. Cauda bluntly conical, bearing 2 pairs of lateral hairs. Fore wings with 2d. fork of media about .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae distinctly swollen and bearing numerous small sensoria along almost entire length. Males alate.

Collections.—On *Salix* sp. *Ligusticum Porteri* and the following *Umbelliferae: Cicuta* sp.; *Carum Petroselinum, Pastinaca sativa; Heracleum lanatum* and *Berula erecta* at Eldora, Colo-

rado Springs, Tolland and Fort Collins; fundatrices Mar. 16 to 19 on *Salix* sp., apterous summer viviparae Mar. 19 to Dec. 6 and alate viviparae June 24 to Dec. 6 on *Umbelliferae*, sexuales Oct. 19 to Nov. 1 on *Salix* sp.; 27 collections, rather common.

Cavariella essigi (Gillette).

Gillette, Can. Ent., Vol. 50, p. 94. *Siphocoryne.*

For description see Essig, Pomona Jour. Ent., 1911, p. 534. *Hyadaphis pastinacae.*

Color.—Viviparae.—Pale yellowish-green to bluish-green; alatae with dusky dorsal dashes and lateral areas on abdomen; all appendages pale to slightly dusky.

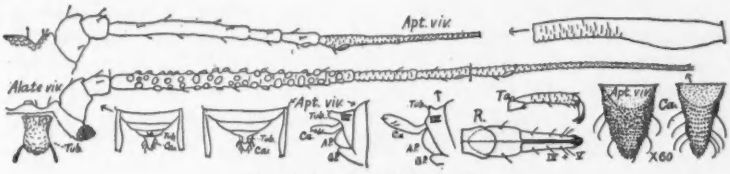


FIG. 184. *Cavariella essigi.*

Measurements.—Apterous summer vivipara.—Body 2 to 2.2 mm.; hind tibiae 1.2 mm.; hind tarsi .15 to .17 mm.; antennae 1.07 mm.; III .33 to .36 mm.; IV .09 to .10 mm.; V .09 mm.; VI .09 + .30 to .32 mm.; cornicles .50 mm.; cauda .12 mm. hard portion, .16 mm. entire length; rostrum obtuse, joint IV + V .15 mm.; attaining 2d. coxae. Alate vivipara.—Body 1.9 to 2.1 mm.; hind tibiae 1.3 to 1.4 mm.; hind tarsi .15 mm.; antennae 1.4 to 1.6 mm.; III .55 to .60 mm.; IV .14 to .18 mm.; V .13 to .15 mm.; VI .09 + .32 to .46 mm.; cornicles .38 to .45 mm.; cauda and rostrum as in apterae.

Structural Characters.—Vertex distinctly convex. Frontal tubercles developed equal with vertex. Dorsal integument of apterae shagreened. Secondary sensoria circular, irregular in size, strongly tuberculate, scattered over entire joint, 35 to 48 on III, 0 on IV or V in alate viviparae; absent in apterae. Hairs slightly capitate; on vertex .03 mm., on antennae and outside of tibiae .02 to .03 mm. Cornicles slightly clavate, with flange and transversely wrinkled proximally. Cauda conical, stout in apterae, rather slender in alatae, and bearing 3 or 4 hairs on each side. Fore wings with 2d. fork of media .33 the distance from margin of wing to 1st. fork. Sexuales unknown.

Collections.—On *Salix laevigata* and *Heracleum lanatum* at Eldora and Fort Collins; apterous and alate viviparae from June 18 to Aug. 10; 10 collections, rather common.

Taxonomy.—This species is very close to *C. pastinacae* L. according to Theobald but differs from Theobald's description

in antennae of apterae being one-half, not one-third of body, cornicles of apterae longer than III + IV, not "nearly equal" and cornicles of alatae being three times cauda, not "twice".

Cavariella theobaldi (Gillette).

Gillette, Can. Ent., Vol. 50, p. 92, 1918. *Aphis.*

Color.—Viviparae.—Yellowish or pale greenish; cornicles yellowish.

Measurements.—Apterous summer vivipara.—Body to base of cauda 1.60 to 2 mm.; hind tibiae 1 mm.; hind tarsi .14 mm.; antennae 1.20 mm.; III .37 to .40 mm.; IV .14 to .16 mm.; V .11 to .12 mm.; VI .08 + .28 to .30 mm.; cornicles .35 to .40 mm.; cauda entire length .16 mm., hard portion .11 mm. Alate vivipara 1.50 to 2 mm.; hind tibiae 1.10 mm.; hind tarsi .14 mm.; antennae 1.15 to 1,50 mm.; III .45 to .48 mm.; IV .12 to .19 mm.; V .11 to .15 mm.; VI .08 + .28 to .35 mm.; cornicles .28 to .30 mm.; cauda entire length .15 mm. hard portion .10 mm.; rostrum slender, obtuse ventrally, joint IV + V .13 mm. long, attaining between 2d. and 3d. coxae.

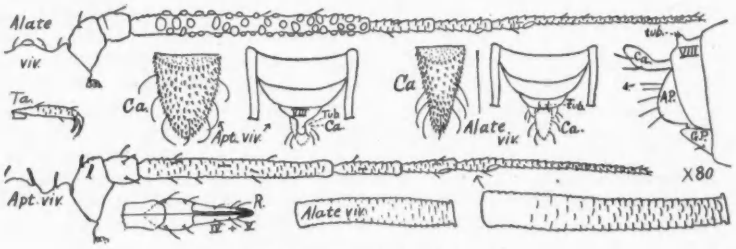


FIG. 185. *Cavariella theobaldi.*

Structural Characters.—Body surface of apterae rough, apparently closely and deeply pitted. Secondary sensoria round, tuberculate and strongly convex, diameter over half diameter of antennal joint, scattered over entire length of joint, about 40 in number on III in alate viviparae, none on other joints; absent in apterae. Hairs blunt, especially in apterae, drooping, sparse, .02 to .03 mm. long on antennae, vertex and tibiae; on cauda about .07 mm. long and slightly curved. Cornicles cylindrical to slightly tapering and gently curved outward, imbricated and with distinct flange. Cauda conical, bearing about 3 hairs on each side and one on dorsum. Fore wings with 2d. fork of media from .33 to .5 the distance from margin of wing to first fork, sometimes obsolete. Males unknown.

Collections.—On leaves and twigs of *Salix* sp. and *Apium graveolens* (celery). No typical examples taken in the state but two collections taken in Colorado Springs June 22 and Oct. 19 may possibly be fundatrices and oviparae respectively;

alate and apterous summer viviparae taken in New York at Geneva and Albany and in Mass. at Webster June 19 to July 1; evidently rare if present in Colorado.

Types in U. S. Nat. Mus., Cat. No. 41928; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species is given by Theobald (Aph. of Gr. Brit., Vol. 2, p. 171, 1927) as a synonym of *Aphis saliceti* Kalt. He was undoubtedly judging from his own material, a mixture of *Aphis saliceti* and *Rhopalosiphum capreae*, used for article (Rep. on Ec. Zoo., p. 84, 1912) to which Gillette refers in his original description. However, since the original description was from actual specimens taken in America presenting this combination of characters, the species surely must stand independently of errors in Gillette's interpretation of Theobald's material above-mentioned.

There seems to be a very close resemblance to *Cavariella umbellatarum* (Koch) as described by Theobald (Aphid. Gr. Brit., Vol. 2, p. 15, 1927) but in alatae antennal joint IV is figured as more than .33 the length of III, and IV + V exceeds .75 of III, while in *theobaldi* IV is usually less than .33 of III, and IV + V is equal to only .5 to .66 of III; the cornicles appear in Theobald's and Koch's descriptions to exceed .66 of III, while in Gillette's species they do not exceed .66. The dark dorsal markings on abdomen also dark color of cornicles mentioned by Theobald and Koch appear to be absent in the American specimens. Until further study shows these differences to be invalid it seems that the species must be considered as distinct.

Genus **Cerosipha** Del Guercio.

Del Guercio, Nuove Rel. Staz. Firenze, Ser. 1, No. 2, p. 116, 1900.

Characters.—Vertex slightly convex. Frontal tubercles slightly developed but not exceeding vertex. Secondary sensoria circular. Antenna 5-jointed in both apterae and alatae. Cornicles cylindrical. Cauda cylindrical or slightly constricted. Rostrum with terminal joint indistinct.

[Genotype **Cerosipha passeriniana** Del. G.]

Del Guercio, loc. cit.

This species is not described here due to inability either to obtain specimens or to gain access to published descriptions.

Cerosipha rubifolii (Thomas).

Thomas, Eighth Rept. St. Ent. Nox. & Ben. Ins. Ill., p. 121, 1879. *Sipha.*

Color.—Apterous vivipara.—Pale greenish-yellow; cauda, cornicles and legs pale.

Measurements.—Apterous vivipara.—Body 1.2 mm. to base of cauda; hind tibiae .45 to .50 mm.; hind tarsi .06 to .07 mm.; antennae .50 to .60 mm.; III .15 to .19 mm.; IV .06 to .08 mm.; V .07 to .09 + .13 to .17 mm.; cornicles .10 to .19 mm.; cauda .07 mm. hard portion, .10 mm. entire length; rostrum obtuse, joint IV + V .10 to .12 mm., attaining between 2d. and 3d. coxae.

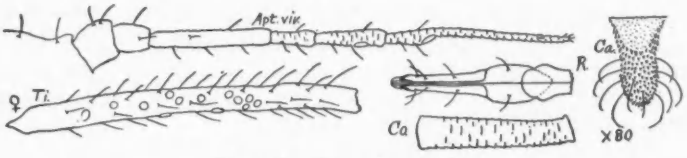


FIG. 186. *Cerosipha rubifolii.*

Structural Characters.—Vertex convex. Frontal tubercles slightly developed, not exceeding vertex. Hairs pointed; .04 mm. long on vertex; .02 to .03 mm. on antennae and tibiae; .05 mm. long and curved on cauda. Cornicles cylindrical or slightly tapering, with flange and imbricated. Cauda short-cylindrical, bluntly rounded, sometimes slightly constricted, bearing 3 or 4 pairs of lateral hairs and 2 mediodorsal ones. Oviparae with hind tibiae very slightly swollen and bearing 0 to 12 faint, nearly flat, sensoria along basal .75 of length.

Collections.—On leaves of *Rubus strigosus* and sp. at Fort Collins, Cherokee Park, and Poudre Canon; apterous summer viviparae Aug. 7, oviparae Sept. 24 to Oct. 27; 5 collections, apparently rare.

Genus **Epameibaphis** Oestlund.

Oestlund, 19th. Rept. St. Ent. Minn., p. 132, 1922.

Characters.—Frontal tubercles absent. Vertex nearly flat. Sensoria circular. Cornicles cylindrical with conspicuous knob-like flange. Cauda conical. Wing venation as in genus *Aphis.*

Genotype **Epameibaphis frigidae** (Oestlund).

Oestlund, Geol. Surv. Minn., 14th. Rept., p. 46, 1886. *Aphis.*

For fuller description see Oestlund, Geol. and Nat. Hist. Surv. Minn., Bul. 4, p. 65, 1887. *Aphis.*

Color.—Viviparae.—Pale glaucous-green, pulverulent and bearing numerous colorless capitate hairs which contribute to the frosted appearance; cauda and cornicles pale; legs and antennae mostly pale.

Sexuales somewhat darker; oviparae with swollen proximal portion of hind tibiae black.

Measurements.—Apterous vivipara.—Body to base of cauda 1 to 1.30 mm.; hind tibiae .60 to .80 mm.; hind tarsi .11 to .13 mm.; antennae 1.15 to 1.33 mm.; III .20 to .31 mm.; IV .15 to .23 mm.; V .11 to .13 + .36 to .50 mm.; cornicles .40 to .53 mm.; cauda .11 mm. hard portion, .14 mm. entire length; rostrum with joint IV + V .18 mm. long, very slender and acute, attaining 1st. abdominal segment. Alate vivipara.—Same as aptera except antennae 1.30 to 1.50 mm.; III .36 to .39 mm.; IV .26 mm.; V .22 to .24 mm.; VI .13 + .45 to .50 mm.; cornicles .40 mm.

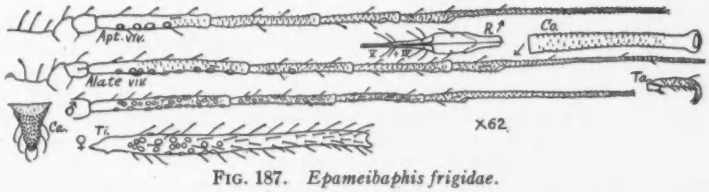


FIG. 187. *Epameibaphis frigidae.*

Structural Characters.—Vertex nearly flat; in alatae with median tubercle-like process bearing the ocellus. Frontal tubercles absent. Secondary sensoria circular with very narrow rims, arranged in single row along most of joint, on III about 10, on IV 0 to 3 in alate viviparae; 1 to 4 on III on basal to middle portion in apterae. Hairs distinctly capitate, on body conspicuous, .05 to .07 mm. long and numerous; faintly capitate on legs .03 to .05 mm. long; on antennae .02 to .03 mm. and sparse; on cauda pointed and curved, .06 mm. long. Cornicles cylindrical, slightly curved, with flange knob-like. Cauda conical, slightly longer than wide, bearing 3 lateral pairs of hairs and one on dorsum near tip. Lateral tubercles absent. Hind wings with media and cubitus present; fore wings with media twice-branched; 2d. fork between .33 and .5 the distance from margin of wing to 1st. fork. Oviparae with proximal .33 to .5 of hind tibiae swollen and covered with large flat sensoria. Males alate.

Collections.—On leaves and stems of *Artemisia frigida* near Boulder, Fort Collins, La Porte and Loveland; fundatrix (?) Mar. 20, apterous summer viviparae May 27 to Dec. 3, alate viviparae May 28 to July 2; sexuales Nov. 2 to 10; 23 collections, common.

Taxonomy.—Our specimens have somewhat longer antennal joints than the measurements in Oestlund's description (1887) but as no other differences are apparent it seems best to consider them under Oestlund's species.

Genus **Flabellomicrosiphum,** new genus.

Characters.—Vertex slightly convex. Frontal tubercles but slightly developed, not noticeably exceeding vertex. Secondary sensoria circular. Cornicles merely raised pores. Cauda elongate, conical or cylindrical. Anal plate rounded. Hairs broadly flabellate. Wing venation as in genus *Aphis*. Rostrum with terminal joint indistinct. Ocular tubercles indistinct. Lateral tubercles not evident.

Genotype **Flabellomicrosiphum tridentatae** (Wilson).

Wilson, Trans. Amer. Ent. Soc., Vol. 41, p. 89, 1915. *Chaitophorus.*

Color.—Viviparae.—Pale green; covered with white fan-shaped hairs, giving frosted appearance; cauda greenish or slightly dusky; legs pale. Oviparae with proximal .3 to .4 of hind tibiae blackish.

Measurements.—Apterous vivipara.—Body 1 to 1.4 mm. to base of cauda; hind tibiae .45 to .55 mm.; hind tarsi .10 mm.; antennae .65 to .80 mm.; III .11 to .17 mm.; IV .10 mm.; V .11 mm.; VI .10 + .15 mm.; cornicles .01 to .015 mm.; cauda .12 mm. hard portion, .14 mm. entire length; rostrum acute, joint IV + V .09 mm. long, tapering, laterally compressed, tip beyond hairs very slender resembling distinct 5th. joint. Alate vivipara.—Same as aptera.

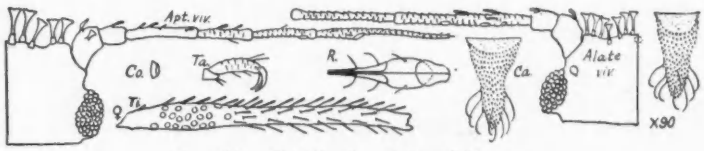


FIG. 188. *Flabellomicrosiphum tridentatae.*

Structural Characters.—Vertex slightly convex. Frontal tubercles slightly developed, not exceeding vertex. Secondary sensoria circular and flat, 1 to 5 on III, 0 on IV or V; absent in apterae. Hairs on body in both alatae and apterae broadly fan-shaped with slender shaft and on slightly broadened base or pedicle, numerous and erect, .05 mm. long; on antennae but slightly capitate, .01 mm. long, drooping and sparse; on outer side of hind tibiae, blunt, drooping and .02 to .03 mm. long, longer than diameter of tibiae and fairly numerous; on cauda pointed, curved and .03 to .04 mm. long. Cornicles truncate, conical or slightly mammiform, without flanges, not imbricated, hardly more than raised pores. Cauda conical to cylindrical, elongate, rather acute, bearing 3 or 4 hairs on each side and 2 or 3 dorsal ones near tip. Ocular tubercles not evident. Mediae of fore wings twice forked. Oviparae with proximal .3 to .4 of hind tibiae distinctly swollen and bearing about 14 flat sensoria.

*Collections.**—On leaves and flower stems of *Artemisia*

*Alate viviparae used in description were kindly presented to our collection by H. F. Wilson, collected at Hermiston, Oregon, May 2, 1914. Oviparae used were kindly presented by Ralph H. Smith, taken at Twin Falls, Idaho, Nov. 4, 1919.

tridentata at Paonia; apterous summer viviparae July 26; only one collection, apparently rare.

Taxonomy.—This genus differs from *Durocapillata* Knowlton in the peculiar hairs, minute cornicles and rudimentary ocular tubercles. It differs from *Capitophorus* Van der Goot in undeveloped frontal tubercles and the minute cornicles. From *Chaitophorus* Koch it is distinguished by the hairs, cornicles and elongate cauda and from *Cryptosiphum* Buckton by the elongate cauda as well as the character of the hairs.

Genus **Hyalopterus** Koch.

Koch., Die Pflanz, Aphiden, p. 16, 1857.

Characters.—Vertex distinctly convex. Frontal tubercles developed equal with vertex. Secondary sensoria circular, convex. Hairs inconspicuous, pointed. Cauda parallel-sided to elongate-conical to spoon-shaped. Cornicles cylindrical to slightly clavate, without flanges. Fore wings with mediae twice-branched. Rostrum obtuse. Lateral tubercles present.

Genotype, *Aphis arundinis* Fabricius. (See below.)

KEY TO SPECIES OF HYALOPTERUS.

A. Cornicles without flanges; not longer than width of cauda at base. (Page 473) ..... **arundinis**

AA. Cornicles with flanges; longer than width of cauda at base. (Page 474), **atriplicis**

Genotype **Hyalopterus arundinis** (Fab.).

Fabricius, Syst. Ent., p. 734, 1775. *Aphis*, and p. 212, 1794. *Aphis pruni.*

Color.—Viviparae.—Yellow-green, with powdery areas dorsolaterally leaving 3 longitudinal greener lines; cornicles, cauda and legs pale.

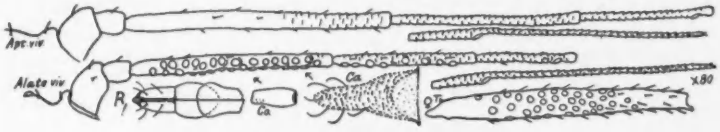


FIG. 189. *Hyalopterus arundinis.*

Measurements.—Apterous summer vivipara.—Body 2.1 mm.; hind tibiae 1.1 mm.; hind tarsi .17 mm.; antennae 1.95 to 2 mm.; III .50 to .53 mm.; IV .36 to .39 mm.; V .28 to .30 mm.; VI .11 + .41 to .43 mm.; cornicles .11 mm., shorter than width of cauda at base; cauda .15 mm. hard portion, .20 mm. entire length; rostrum obtuse, joint IV + V broad, width at base exceeding half of length; .08 mm. long; attaining 2d. coxae. Alate vivipara.—Body 1.5 to 1.9 mm.; hind tibiae 1 mm.; hind tarsi .15 mm.; antennae 1.4 to 1.8 mm.; III .36 to .47 mm.; IV .23 to .31 mm.; V .20 to .26 mm.; VI .11 + .39 to .46 mm.; cornicles .07 to .11 mm.; cauda and rostrum as in apterae.

Structural Characters.—Secondary sensoria circular, convex to slightly tuberculate, scattered in double row, about 27 in number along entire length on III, in single row 3 to 8 on IV, 0 on V in alatae; absent in apterae. Hairs pointed, sparse; .01 mm. on antennae; .01 mm. on vertex in alatae, .03 mm. in apterae; on outer side of hind tibiae .02 mm. in alatae, .03 mm. in apterae; on cauda .04 to .05 mm., curved. Cornicles cylindrical to slightly clavate, weak, without flanges, not imbricated. Cauda cylindrical to elongate conical with rather abruptly broadened base, suggesting slight neck, bearing 2 or 3 pairs of lateral hairs and one on tip. Lateral tubercles present on prothorax and all abdominal segments. Fore wings with 2d. fork of media .33 of the distance from margin of wing to 1st. fork. Oviparae with hind tibiae distinctly swollen along almost entire length and bearing numerous, rather large, nearly flat sensoria. Males alate.

Collections.—On leaves of plum and apricot as winter hosts and in part as summer hosts and *Phragmites communis* (grass) as summer host generally throughout the state; fundatrices in May on *Prunus*, apterous and alate viviparae from May to Nov. on both *Prunus* and grass; sexuales Oct. 1 to Nov. 14 on *Prunus;* very numerous collections, very common and injurious.

Hyalopterus atriplicis (Linnaeus).

Linnaeus, Fauna Svecia, Ed. alt., p. 262, 1761. *Aphis.*
Syn. *Aphis chenopodii* Cowen, "Hemip. Colo.," Agr. Exp. Sta., Bul. 31, p. 119, 1895.

Color.—Viviparae.—Yellowish-green; apterae mottled with darker green on abdomen and brown on head; powdery; alatae with dusky lateral areas and dorsal dashes; cauda and cornicles pale to dusky especially at tips; legs pale brownish.

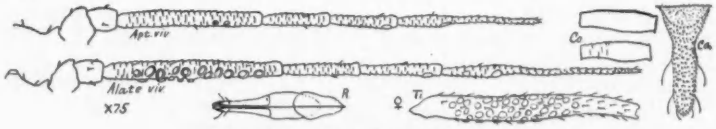


FIG. 190. *Hyalopterus atriplicis.*

Measurements.—Apterous summer vivipara.—Body to base of cauda 1.60 mm.; hind tibiae .70 to .75 mm.; hind tarsi .14 mm.; antennae 1 mm.; III .24 to .33 mm.; IV .10 to .14 mm.; V .11 to .14 mm.; VI .10 to .11 + .16 to .24 mm.; cornicles .13 to .17 mm.; cauda .15 to .18 mm. hard portion, .20 to .23 mm. entire length; rostrum obtuse, joint IV + V .12 mm.; attaining 2d. coxae. Alate vivipara.—Body 1.50 mm.; hind tibiae .93 mm.; hind tarsi .15 mm.; antennae 1.1 to 1.2 mm.; III .33 to .43 mm.; IV .16 to .20 mm.; V .16 to .18 mm.; VI .11 to .14 + .21 to .33 mm.; cornicles .11 to .14 mm., long and same width as hind tibiae; cauda .13 to .15 mm. hard portion, .17 to .20 mm. entire length; rostrum attaining half-way between 1st. and 2d. coxae.

Structural Characters.—Secondary sensoria circular, rather large, 12 to 19 in number on III; 0 on IV or V; absent in apterae. Hairs pointed, sparse; .01 mm. long on vertex, antennae and outer side of tibiae; .05 mm. long and curved on cauda. Cornicles slightly incrassate, with flanges and not imbricated. Cauda elongate-spoon-shaped with two pairs of lateral and one pair of terminal hairs. Lateral tubercles present on prothorax and all abdominal segments. Fore wings with 2d. fork of media about .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae distinctly swollen for almost entire length and covered with rather large subcircular sensoria.

Collections.—In longitudinally folded leaves of *Chenopodium album* generally throughout the state; fundatrices May 8 to 24, apterous summer viviparae May 18 to Aug. 18, alate viviparae May 25 to July 19, oviparae Sept. 30 to Oct. 20, males not taken; over 50 collections, very common.

Taxonomy.—This species has been used as type for the subgenus *Hayhurstia* by Del Guercio (Redia, Firenze, Vol. 4, Fasc. I, p. 191-2, 1906).

Genus **Microsiphum** Cholodkovski.

Cholodkovski, Zool. Anz., Vol. 32, p. 687, 1908.

Characters.—Frontal tubercles moderately developed but not exceeding vertex. Secondary sensoria circular. Cornicles not longer than broad at base, truncate or short-cylindrical. Cauda broader than long, conical with narrowed tip. Fore wings with mediae twice-forked. Hairs blunt to slightly capitate.

[Genotype **Microsiphum ptarmicae** Chol.]

This species not described here on account of lack of specimens and inaccessibility of published descriptions. We are following description of the genus by Baker (U. S. D. A. Bul. 826, p. 49, 1920).

Microsiphum artemisiae (Gillette.)

Gillette, Ent. News, Vol. 22, p. 440, 1911. *Chaitophorus.*

Color.—Viviparae.—Dark blackish-brown to cinnamon-brown; shining; cornicles and cauda dusky; legs pale on most of tibiae, other parts brown to black. Young, greenish. Oviparae.—Olive-brown. Males.—Greenish-brown.

Measurements.—Apterous summer vivipara.—Body 1.6 to 2 mm.; hind tibiae .90 mm.; hind tarsi .15 mm.; antennae 1.40 to 1.95 mm.; III .30 to .41 mm.; IV .22 to .33 mm.; V .21 to .29 mm.; VI .12 + .40 to .66 mm.; cornicles .04 mm. long and .04 mm. wide at base and .03 mm. wide at tip; cauda .06 mm. hard portion, .08 mm. entire length, slightly broader at base than entire length; rostrum acute, joint IV + V

laterally compressed, quickly tapering in ventral aspect, .12 to .13 mm. long, tip beyond hairs very slender, resembling distinct 5th. joint, attaining between 2d. and 3d. coxae. Alate vivipara.—Body 1.4 to 1.5 mm.; hind tibiae .82 to 1 mm.; all other parts as in apterous viviparae except rostrum hardly surpassing 2d. coxae. Oviparae.—Body 2 mm., other parts as in viviparae. Males.—Body 1.3 mm.; hind tibiae .58 mm.; antennae as in apterous viviparae.

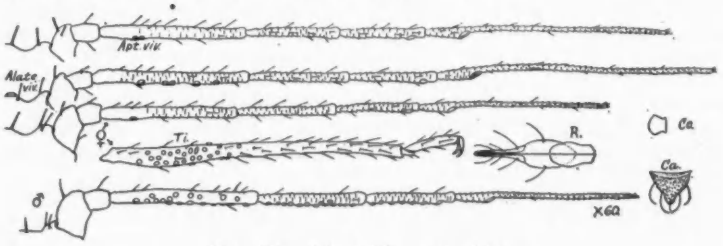


FIG. 191. *Microsiphum artemisiae.*

Structural Characters.—Secondary sensoria circular, arranged in a single row along posterior side of joint, 3 to 6* on III, 0 on IV or V in alate viviparae; 1 to 6 on basal portion of III in apterous viviparae and oviparae; in males numerous small sensoria along posterior sides of III, IV and V. Hairs blunt or slightly capitate, rather heavy; .03 to .05 mm. long on vertex; .02 to .03 mm. on antennae and outer side of hind tibiae; .05 to .06 mm. long on cauda. Cornicles short-cylindrical or truncate, with flange and faintly wrinkled transversely or smooth. Cauda broadly conical with tip narrowly conical, bearing two pairs of lateral hairs and a single apical one. Lateral tubercles shallow and broad. Fore wings with mediae twice forked and with 2d. fork about .33 to .5 the distance from margin of wing to 1st. fork. Oviparae similar to apterous viviparae but more pointed and elongate posteriorly and with hind tibiae pale except tips and slightly swollen on basal .33 and bearing scattered sensoria, circular to oval and small. Males apterous.

Collections.—On leaves and stems of *Artemisia aromatica* (formerly *dracunculoides*) generally on the eastern slope of the Rockies and on *Artemisia tridentata* at Craig, Gunnison and Antonito; apterous summer viviparae May 18 to Sept. 22, alate viviparae May 18 to July 14, sexuales Sept. 25 to Oct. 25; 30 collections, not common but very abundant on individual plants.

*About 6 collections were taken in which the secondary sensoria in alate viviparae numbered 8 to 11 on III and joint IV + V of rostrum measured .15 to .16 mm., attaining beyond 2d. coxae in alatae and attaining or surpassing 3d. coxae in apterae. No other differences were observed and the hosts were the same except for the addition of *Artemisia ludoviciana*. Whether these differences are stable and justify establishing a distinct species or simply exhibit variations of the one species it is impossible for the authors to determine at present.

Types in U. S. Nat. Mus., Cat. No. 41937; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species is closely allied to *Cryptosiphum canadensis* Williams but differs in color, Williams' species being green in the adult stage. Furthermore, the Colorado specimens were not curling leaves as Williams' species is described as doing.

Genus **Pseudoepameibaphis** Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 25, p. 145, 1932.

Characters.—Vertex nearly flat. Frontal tubercles absent. Ocular tubercles rudimentary. Hairs blunt or fan-shaped. Cornicles slender, slightly swollen distally on inner side, impinged against abdomen, and with thin-edged flange set obliquely. Cauda conical. Lateral tubercles not evident. Wing venation as in genus *Aphis*.

Taxonomy.—This genus differs from *Epameibaphis* Oestlund only in shape of the cornicles.

Genotype **Pseudoepameibaphis glauca** Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 25, p. 145, 1932.

Color.—Viviparae.—Glaucous-green; slightly powdery throughout; cauda pale; cornicles pale with dusky tips, legs mostly pale; wing veins brown, rather heavy. Sexuales olive-green to brown.

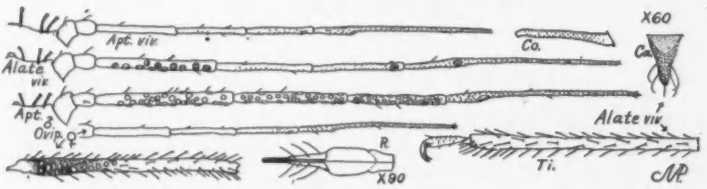


FIG. 192. *Pseudoep. glauca.*

Measurements.—Alate viviparae.—Body 1.2 to 1.5 mm.; hind tibiae .70 to .75 mm.; hind tarsi .12 mm.; antennae 1.4 mm.; III .27 to .30 mm.; IV .22 to .27 mm.; V .18 to .23 mm.; VI .14 + .37 to .40 mm.; cornicles .20 mm.; cauda .08 mm. hard portion, .12 mm. entire length; rostrum slender, acute, joint IV + V .12 mm. portion beyond hairs slender and needle-like in ventral aspect, .06 mm. long, resembling distinct 5th. joint, attaining 2d. coxae. Apterous vivipara.—Body 1.20 mm.; hind tibiae .55 to .60 mm.; antennae 1 to 1.1 mm.; III .16 to .25 mm.; IV .16 to .24 mm.; V .15 to .19 mm.; VI .11 to .13 + .31 to .42 mm.; cornicles .19 to .23 mm.; cauda .10 mm. hard portion; rostrum attaining 3d. coxae.

Structural Characters.—Vertex flat. Frontal tubercles lacking. Secondary sensoria circular, flat, scattered along entire length of III, 5 to 9 in number, on IV 0 to 1 in alatae; absent in apterae. Hairs slightly capitate; on vertex .04 mm. long in alatae; in apterae on vertex and body .05 mm. and conspicuous; on antennae .015 to .02 mm., very sparse, and inconspicuous; on middle of hind tibiae, outer side .03 mm. Cornicles slender, not as wide as hind tibiae, slightly swollen on inner side of distal .33; flange distinct and thin-rimmed, oblique. Cauda conical bearing two pairs of lateral hairs and a single dorsal one. Lateral tubercles and ocular tubercles not evident. Fore wings with media twice-forked; hind wings with both media and cubitus. Oviparae with hind tibiae somewhat swollen and darkened on proximal third and bearing about 12 flat sensoria. Males apterous, and with vertex bearing median ocellus as in alatae.

Collections.—On leaves and stems of *Artemisia frigida;* near Fort Collins, La Porte and Poudre Canon; apterous summer viviparae Mar. 20 to Oct. 12, alate viviparae April 15 to June 2, oviparae Oct. 30 to Dec. 3, males Nov. 6 to Dec. 3; 10 collections, rather common but difficult to detect on account of protective coloration and agility in escaping.

Types in U. S. Nat. Mus., Cat. No. 43846; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species very closely resembles *Pseudoepameibaphis tridentatae* (Wilson) but differs from Wilson's description in longer antennae and cauda. This species is found mingled with *Epameibaphis frigidae* Oestlund but is easily separated by the different cornicles.

Genus **Rhopalosiphum** Koch.

Koch., Die Pflanz. Aphiden, p. 23, 1854.

Characters.—Frontal tubercles hardly developed beyond vertex. Secondary sensoria circular, with narrow rims. Cornicles swollen, clavate, longer than entire length of cauda. Cauda cylindrical or conical. Hairs pointed or blunt. Wing venation as in genus *Aphis*. Living exposed on leaves and twigs of plants.

Genotype, *Aphis nympheae* Linn. (See below.)

KEY TO SPECIES OF RHOPALOSIPHUM.

A. Cornicles twice as wide in distal half as at base. (Page 480)..... **berberidis**
AA. Cornicles less than twice as wide in distal half as at base.
  B. Cauda conical.
    C. Cauda longer than broad.
      D. Cornicles longer than unguis. (Page 484)..... **melliferum**
      DD. Cornicles not longer than unguis. (Page 487)..... **pseudobrassicae**
    CC. Cauda not longer than broad.
      D. Cauda constricted near tip. Cornicles not constricted distally.
        E. On *Poa pratensis.* (Page 485)..... **poae**
        EE. On *Lonicera.* (Page 483)..... **grabhami**

DD. Cauda without constriction. Cornicles constricted distally. (Page 491)..... **serotinae**
BB. Cauda cylindrical or spoon-shaped.
C. Rostrum acute. (Page 489)..... **rufomaculata**
CC. Rostrum obtuse.
D. Cornicles at least subequal with III in alatae, longer in apterae.
E. Cauda spoon-shaped; bearing 2 pairs of hairs. (Page 479), **nympheae**
EE. Cauda not spoon-shaped; bearing 4 pairs of hairs. (Page 481), **bossekiae**
DD. Cornicles shorter than III in alatae, hardly longer in apterae.
E. Hairs blunt or capitate. Sensoria absent in IV of alatae. Cornicles smooth. (Page 488)..... **rhois**
EE. Hairs pointed. Sensoria on IV of alatae. Cornicles imbricated.
F. Unguis 3 to 4 × base of VI. Sensoria 18 to 24 on III of alatae. (Page 490)..... **scirpifolii**
FF. Unguis 4 to 5 × base of VI. Sensoria 12 to 24 on III of alatae. (Page 486)..... **prunifoliae**
FFF. Unguis 5 to 6 × base of VI. Sensoria less than 12 on III of alatae. (Page 482)..... **enigmae**

Genotype **Rhopalosiphum nympheae** (Linn.).

Linn., Fauna Svecia, Ed. Alt., 1746 Ed., p. 260, 1761. *Aphis.*

For fuller description see Theobald, Aph. Gr. Br., Vol. 2, p. 60, 1927.

Color.—Viviparae.—Light olive-green to golden-brown; apterae pulverulent on sides of head and prothorax; all appendages dusky; cornicles lighter proximally.

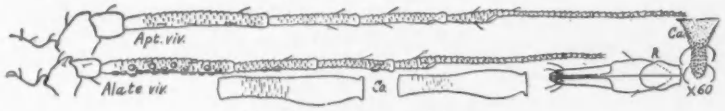


FIG. 193. *Rhop. nympheae.*

Measurements.—Apterous summer vivipara.—Body 2 to 2.30 mm.; hind tibiae .95 to 1.10 mm.; hind tarsi .15 mm.; antennae 1.20 to 1.50 mm.; III .20 to .37 mm.; IV .24 to .29 mm.; V .16 to .25 mm.; VI .12 to .14 + .37 to .47 mm.; cornicles .30 to .50 mm.; cauda .14 mm. hard portion, .24 mm. entire length. Rostrum obtuse, with joint IV + V .15 mm. long, attaining 3d. coxae. Alate vivipara.—Body about 2 mm.; hind tibiae 1.20 mm.; antennae as in apterae; cornicles .30 to .41 mm.; cauda .09 mm. hard portion, .14 mm. entire length.

Structural Characters.—Vertex distinctly convex. Frontal tubercles distinctly developed mesally but not attaining vertex. Secondary sensoria circular, scattered along posterior half on entire length of joint, 14 to 23 on III; 0 to 7 on IV in alatae; absent in apterae. Cornicles clavate, swollen on distal half and with distinct flange, narrow portion with faint transverse wrinkles, otherwise smooth. Hairs pointed; .01 to .02 mm. long on antennae and body; .04 to .05 mm. long on outer side of hind tibiae and cauda. Cauda blunt, cylindrical with slight neck, bearing 2 curved hairs on each side. Lateral tubercles small but present on prothorax and abdominal segments. Fore wings with 2d. fork of mediae about .25 the distance from margin of wing to

1st. fork. Oviparae with hind tibiae considerably swollen and bearing numerous sensoria. Males alate.

Collections.—On leaves and stems of *Batrachium trichophyllum* or *flaccidum*, *Berula erecta*, *Bidens* sp., *Ceratophyllum* sp., *Homalocenchrus oryzoides*, *Mimulus floribundus* (?), *Nymphea polysepala*, *Persicaria* sp., *Polygonum punctatum*, *Sagittaria* sp., *Scirpus* sp., *Typha latifolia*, and *Veronica* sp. at Fort Collins, Longmont and Fruita; apterous and alate summer viviparae June 14 to Dec. 3, sexuales not taken; 35 collections, common.

Rhopalosiphum berberidis (Kaltenbach).

Kaltenbach, Mon. Pflanz., p. 95, 1843. *Aphis.*

Color.—Viviparae.—Yellow tinged with greenish especially on dorsolateral areas, spring forms reddish especially laterally and posteriorly; alatae with head and thorax yellowish-brown; cornicles pale with tip dusky; legs pale with tips of tarsi black. Sexuales.—Yellowish to pink with dusky dorsal dashes, broken medially in oviparae; hind tibiae dusky in oviparae.

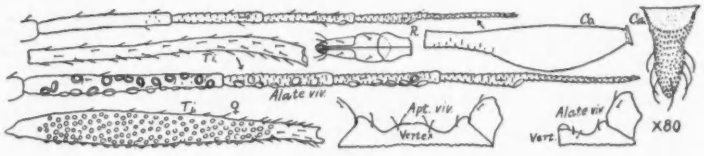


FIG. 194. *Rhop. berberidis.*

Measurements.—Apterous summer vivipara.—Body 1.50 to 1.70 mm. long; hind tibiae .55 to .82 mm.; hind tarsi .12 mm.; antennae .75 to 1 mm.; III .16 to .28 mm.; IV .11 to .17 mm.; V .12 to .17 mm.; VI .10 to .14 + .12 to .17 mm.; cornicles .40 to .50 mm.; cauda .15 mm. on hard portion, .20 mm. entire length; rostrum obtuse, joint IV + V broad .08 to .09 mm. by .05 mm. attaining or slightly surpassing 2d. coxae. Spring vivipara.—Body 2 mm. Alate vivipara.—Body 1.7 to 1.9 mm.; hind tibiae .82 mm.; hind tarsi .12 mm.; antennae 1.25 to 1.50 mm.; III .36 to .38 mm.; IV .21 to .24 mm.; V .19 to .23 mm.; VI .15 to .18 + .20 to .21 mm.; cornicles .36 mm.; cauda as in apterae; rostrum attaining between 1st. and 2d. coxae.

Structural Characters.—Dorsal surface of apterae rugose. Secondary sensoria circular with distinct margins, convex, scattered along entire length of joints, about 22 on III, 6 to 9 on IV, 1 to 5 on V; absent in apterae. Hairs pointed in alatae, slightly capitate or blunt in apterae; .02 to .025 mm. long on vertex; .01 mm. on antennae and outer side of tibiae; .05 mm. long and curved on cauda. Cornicles club-shaped, .04 mm. wide basally .09 mm. in distal half, constricted at tip, with flange, smooth. Cauda long-conical, with 3 pairs of lateral hairs.

Fore wings with 2d. fork of media .3 to .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae distinctly swollen and thickly covered with small convex sensoria. Males alate.

Collections.—On leaves or bark of *Berberis vulgaris* at Fort Collins and Greeley; fundatrices and hibernating females March 25 to April 8, apterous summer viviparae April 27 to Nov. 14, alate viviparae May 19 to Dec. 2, sexuales Oct. 2 to Nov. 29; 37 collections, common.

Taxonomy.—This species was made genotype of the genus *Liosomaphis* by Walker (The Zoologist, p. 1119, 1868) on the character of marked constriction of the basal portion of the cornicles. This character is only relative and, in the opinion of the writers, is only of subgeneric value.

Rhopalosiphum bossekiae Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 22, p. 474.

Color.—Viviparae.—Light greenish-yellow to pale green, streaked or mottled with darker green; appendages rather pale.

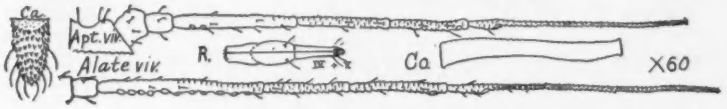


FIG. 195. *Rhop. bossekiae.*

Measurements.—Apterous summer vivipara.—Body to base of cauda 1.80 mm.; hind tibiae .60 to 1.10 mm.; hind tarsi .11 mm.; antennae .90 to 1.30 mm.; III .20 to .42 mm.; IV .13 to .31 mm.; V .14 to .26 mm.; VI .10 + .30 to .55 mm.; cornicles .36 to .55 mm.; cauda .11 mm.; rostrum obtuse, joint IV + V slender, .12 mm. long, attaining between 2d. and 3d. coxae. Alate vivipara.—Same as aptera to slightly longer.

Structural Characters.—Vertex convex. Frontal tubercles developed equal with vertex. Secondary sensoria circular, arranged in single row on III, 5 to 12 in number; absent on IV and V in alatae; in apterae 0 to 3 on III. Hairs blunt to capitate; on antennae .01 mm. long and sparse; on body and legs .03 to .14 mm. long and fairly numerous; on cauda pointed, .05 to .06 mm. long and curved. Cornicles somewhat swollen on inner side of distal third, slightly curved at base, transversely rugose on basal third, with slight flanges. Cauda cylindrical or slightly tapering, obtuse, bearing 3 or 4 hairs on a side. Lateral tubercles inconspicuous, present on abdominal segments 2, 3 and 4. Fore wings with 2d. fork of media about .5 the distance from margin of wing to 1st. fork. Sexuales unknown.

Collections.—On leaves and stems of *Bossekia deliciosa* taken in foothills of the eastern slope of the Rockies in northern Colorado; apterous summer viviparae June 13 to Aug. 30, alate viviparae June 30 and July 1; 7 collections, rare.

Types in U. S. Nat. Mus., Cat. No. 41923; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species resembles *Aphis rubicola* Oestlund but differs greatly in length of antennae and cornicles as well as in shape of cornicles.

Rhopalosiphum enigmae Hottes and Frison.

Hottes and Frison, Ill. Nat. Hist. Surv. Bul., Vol. 19, p. 235, 1931.

Color.—Viviparae.—Brown, yellowish or greenish to reddish or bronzy, often with rusty blotches at bases of cornicles, appendages dusky. *Oviparae.*—Reddish-brown, lighter anteriorly and posteriorly; tibiae pale.

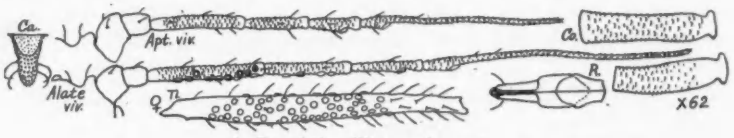


FIG. 196. *Rhop. enigmae.*

Measurements.—Apterous summer vivipara.—Body 2 to 2.4 mm.; hind tibiae .90 to 1 mm.; hind tarsi .14 mm.; antennae 1.05 to 1.30 mm.; III .22 to .30 mm.; IV .11 to .17 mm.; V .12 to .16 mm.; VI .07 to .08 + .40 to .48 mm.; cornicles .25 to .30 mm.; cauda .08 mm. hard portion, .12 mm. entire length. Alate vivipara.—Body 1.80 mm.; hind tibiae .95 to 1 mm.; hind tarsi .13 mm.; antennae 1.35 mm.; III .30 to .33 mm.; IV .18 mm.; V .14 to .18 mm.; VI .08 to .09 + .45 to .55 mm.; cornicles .26 to .29 mm. distinctly wider than hind tibiae; cauda as in apterae; rostrum obtuse, with joint IV + V .12 mm. long, attaining 2d. coxae more or less.

Structural Characters.—Vertex distinctly convex. Frontal tubercles considerably developed, slightly exceeding vertex. Secondary sensoria circular, arranged in a double row along entire length of joint, 11 to 15 on III, 3 to 4 on IV of alatae; absent in apterae. Hairs pointed; .05 mm. long on vertex; .03 mm. on antennae; .05 to .07 mm. on tibiae, rather numerous; .05 mm. on cauda and curved. Cornicles slightly incrassate, constricted just before wide flange, slightly imbricated. Cauda cylindrical, obtuse, bearing 2 hairs on each side. Lateral tubercles present but small. Fore wings with 2d. fork of mediae hardly .2 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae .75 to .85 mm. long, moderately swollen for almost entire length and bearing numerous large sensoria. Males alate.

Collections.—On leaves or stems of *Typha latifolia* near Fort Collins; apterous summer viviparae Aug. 5 to Oct. 8, alate viviparae Aug. 5 to 17, sexuales Oct. 8 to Oct. 30; 13 collections, not common.

Taxonomy.—This species is very close to *Rhopalosiphum prunifoliae* Fitch but differs in color, somewhat longer unguis, thicker cornicles, and longer hind tibiae of oviparae, besides the habit of wintering on *Typha latifolia*. This form varies slightly from the original description of *Rhop. enigmae* in smaller body and shorter antennal joints and cornicles, and more numerous sensoria in the two alate specimens. The limits of variation, however, of the two forms overlap so that the erection of a distinct species for the Colorado form seems hardly justifiable.

Rhopalosiphum grabhami Cockerell.

Cockerell, Can. Ent., Vol. 35, p. 342, 1903.

Color.—Alate vivipara.—Dark olive-brown; appendages pale.

Measurements.—Alate vivipara.—Body to base of cauda 2 to 2.20 mm.; hind tibiae 1.1 to 1.2 mm.; hind tarsi .09 to .10 mm.; antennae 2.25 mm.; III .63 to .67 mm.; IV .34 to .43 mm.; V .34 to .36 mm.; VI .12 + .57 to .65 mm.; cornicles .30 to .35 mm.; cauda .07 to .08 mm. hard portion, .14 mm. entire length; rostrum obtuse, joint IV + V slender .11 mm. long, attaining between 1st. and 2d. coxae.

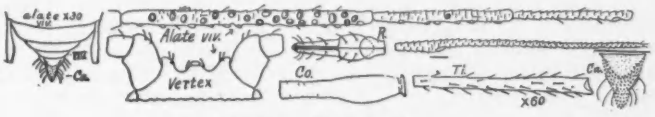


FIG. 197. *Rhop. grabhami.*

Structural Characters.—Vertex distinctly convex. Frontal tubercles produced mesally exceeding vertex. Secondary sensoria circular to oval, convex, scattered along entire length of joints, about 30 on III, 19 to 26 on IV, 0 to 4 on V. Hairs slightly capitate .02 to .03 mm. long on antennae and vertex, on cauda pointed and curved. Cornicles club-shaped, at middle twice as wide as hind tibiae, with flange. Cauda acute, conical, hardly longer than wide, often appearing somewhat constricted near tip, bearing 2 lateral and 1 dorsal pair of hairs. Fore wings with 2d. branch of media .5 more or less of the distance from margin of wing to 1st. fork. Sexuales and apterous viviparae unknown.

Collections.—On *Lonicera utahensis* at Eldora; nymphs of alatae June 24; alate viviparae June 25; one collection of numerous alate specimens; not common.

Rhopalosiphum melliferum (Hottes).

Hottes, Pr. Bio. Soc. Wash., Vol. 43, p. 184, 1930. *Hyadaphis.*
Schrank, Fauna Boica, Vol. 2, p. 107, 1801. *Aphis xylostei.*

For fuller description see Theobald, Aph. Gr. Brit., Vol. 2, p. 52, 1927. *Hyadaphis zylostei.*

Color.—Viviparae.—Pale yellowish-brown in alatae, pale yellowish in apterae; all appendages dusky.

Measurements.—Apterous summer vivipara.—Body 1.5 to 2 mm.; hind tibiae .80 to .85 mm.; hind tarsi .13 to .14 mm.; antennae .90 mm.; III .32 to .39 mm.; IV .13 to .16 mm.; V .09 to .12 mm.; VI .10 + .28 mm; cornicles .20 to .34 mm.; cauda .20 mm. hard portion, .30 mm. entire length; rostrum obtuse, joint IV + V .11 mm., attaining 2d. coxae. Alate vivipara.—Body 1.3 to 1.5 mm.; hind tibiae .90 to 1 mm.; hind tarsi .13 to .15 mm.; antennae 1.15 to 1.50 mm.; III .34 to .48 mm.; IV .12 to .16 mm.; V .11 to .15 mm.; VI .11 + .33 to .45 mm.; cornicles .23 to .33 mm.; cauda .15 mm. hard portion, .20 mm. entire length; rostrum hardly attaining 2d. coxae.

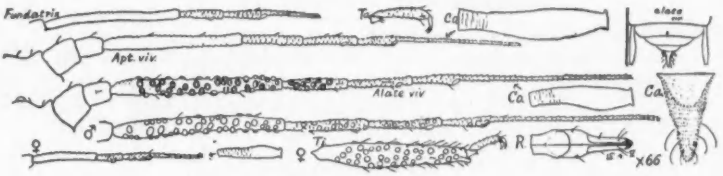


FIG. 198. *Rhop. melliferum.*

Structural Characters.—Vertex slightly convex. Frontal tubercles rudimentary. No dorsal tubercle on 8th. abdominal segment. Secondary sensoria circular, strongly convex, scattered along almost entire joint, 34 to 45 on III and 8 to 25 on IV in alate viviparae; absent in apterae. Hairs pointed, sparse, .01 to .02 mm. on vertex and antennae, .02 to .03 mm. on tibiae. Cornicles clavate, at middle nearly twice as wide as tibiae, transversely rugose proximally, otherwise smooth, with flange. Cauda conical, about 1.5 times as long as wide, acute, bearing 2 pairs of lateral and 1 pair of dorsal hairs. Fore wings with 2d. fork of media .33 to .5 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae strongly swollen and bearing rather large sensoria scattered along almost entire length. Males alate.

Collections.—On leaves of *Lonicera* sp., *Xylosteum* sp. and *Symphoricarpos* sp. as winter hosts and *Cicuta* sp., *Heracleum lanatum, Pastinaca* sp. and *Berula erecta* as summer hosts near Fort Collins; fundatrices May 11 to 26, apterous and alate summer viviparae June 3 to June 30 and Nov. 15 on winter host, June 29 to Aug. 6 on summer host, sexuales Nov. 7 to 12 on winter host; males also on summer host Sept. 27; 32 collections, rather common.

Taxonomy.—This is the species discussed by Gillette (Jo. Ec. Ent., Vol. 4, p. 320, 1911), as *Rhopalosiphum pastinacae* (Linn.).

Rhopalosiphum poae (Gillette).

Gillette, Can. Ent., Vol. 40, p. 61, 1908.

Color.—Viviparae.—Brownish-black to black; cornicles and legs light to dark dusky.

Measurements.—Apterous summer vivipara.—Body to base of cauda 1.9 mm.; hind tibiae 1 mm.; hind tarsi .09 mm.; antennae 1.8 to 1.9 mm.; III .41 to .49 mm.; IV .20 to .37 mm.; V .22 to .30 mm.; VI .13 + .36 to .51 mm.; cornicles .30 mm.; cauda .07 mm. hard portion, .09 mm. entire length; rostrum obtuse, joint IV + V .10 mm., attaining half way between 1st. and 2d. coxae. Alate vivipara.—Body 1.8 mm.; hind tibiae 1.10 mm.; hind tarsi .08 mm.; antennae 2 to 2.40 mm.; III .65 to .77 mm.; IV .44 to .53 mm.; V .33 to .38 mm.; VI .15 + .60 to .75 mm.; cornicles .31 mm.; cauda .05 mm. hard portion, .09 mm. entire length.

Structural Characters.—Vertex distinctly convex. Frontal tubercles developed mesally, distinctly exceeding vertex. Secondary sensoria circular to oval, tuberculate scattered along entire length of joints, about 46 on III, 19 to 26 on IV and 0 to 4 on V in alate viviparae; absent in apterae. Hairs distinctly capitate, .01 to .015 mm. on antennae, vertex and tibiae, on cauda pointed, curved and .03 mm. long. Cornicles club-shaped, with flanges, distal half swollen, twice as wide at middle as hind tibiae. Cauda conical, not longer than broad, often appearing slightly constricted near tip. Lateral tubercles on prothorax. Mediae of fore wings with 2d. fork about .5 of the distance from margin of wing to 1st. fork. Sexuales unknown.

Collections.—On leaves and stems of *Poa* sp. at Fort Collins; alate and apterous viviparae Oct. 15 to Apr. 28; not taken in summer; 26 collections; rather common.

Types in U. S. Nat. Mus., Cat. No. 41947; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species is very close to *Cap. grabhami* (Cockerell) but differs in slightly longer antennal joints, shorter hairs and darker color. These differences, however, intergrade. This fact with the absence of *C. poae* in summer months on grass suggests that possibly both forms are but different generations of the same species. The decision of the question must await biological study.

Rhopalosiphum prunifoliae (Fitch).

Fitch, First Rept. Nox. and Ben. Ins. N. Y., p. 122, 1855. *Aphis.*

For further discussion on taxonomy see Baker, Science N. S., Vol. 46, p. 410, October, 1917.

Color.—Viviparae.—Yellowish-green with darker green markings in form of median line, cross dashes, and lateral margins in fundatrices, and mottlings in summer apterae; orange areas about cornicles and on 6th. abdominal segment in nymphs and summer apterae; dusky lateral areas and median bands on 7th. and 8th. and sometimes on 5th. and 6th. abdominal segments in alatae; cornicles and legs pale or slightly dusky with black tips. Oviparae.—Olive-green.

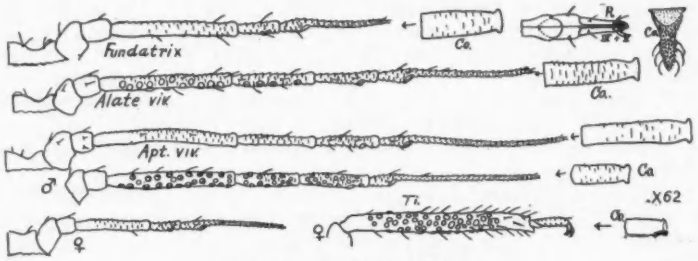


FIG. 199. *Rhop. prunifoliae.*

Measurements.—Apterous summer vivipara.—Body 1.4 to 1.8 mm.; hind tibiae .90 to 1.10 mm.; antennae 1.1 to 1.4 mm.; III .27 to .36 mm.; IV .15 to .22 mm.; V .13 to .18 mm.; VI .09 + .36 to .46 mm.; cornicles .20 to .30 mm.; rostrum obtuse, joint IV + V .11 mm. long, attaining 2nd. coxae. Alate vivipara.—Body 1.8 mm.; hind tibiae .90 to 1 mm.; hind tarsi .11 mm.; antennae 1.1 to 1.4 mm.; III .23 to .40 mm.; IV .12 to .24 mm.; V .12 to .20 mm.; VI .07 to .09 + .27 to .44 mm.; cornicles .20 to .25 mm.; cauda .11 mm. hard portion, .15 mm. entire length.

Structural Characters.—Frontal tubercles distinctly produced mesally, but hardly exceeding vertex, which is convex. Secondary sensoria convex, irregularly scattered over entire joint, 12 to 24 on III, 2 to 10 on IV, 1 to 6 on V in alate viviparae; none in apterae. Hairs on antennae pointed, sparse, drooping; .02 mm. long and hardly as long as diameter of antenna; on vertex .02 mm. on outer side of hind tibiae .03 to .04 mm. Cornicles cylindrical to slightly vasiform, being slightly narrowed in middle and distinctly constricted just before the prominent flange, faintly imbricated, appearing weak, hardly wider in middle than hind tibiae, impinged against body. Cauda elongated, cylindrical, rather acute, slightly constricted near base with 2 or 3 hairs on each side. Mediae of fore wings with 2d. fork from .25 to .33 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae pale, .45 to .50 mm. long, somewhat swollen along entire length and covered with rather large, nearly flat sensoria. Males alate.

Collections.—On leaves and twigs of *Crataegus* sp. and *Pyrus Malus* for winter host and *Avena sativa* and *Graminaceae* for summer host at Fort Collins, Denver, Delta, Grand Junction, Paonia, Rocky Ford, Eckert, Palisade, Cory and Hotchkiss; fundatrices April 25 to June 9, apterous summer viviparae on *P. Malus* and *Crataegus* April 28 to June 26, and Sept. 5 to Nov. 14, on *Graminaceae* June 6 to Nov. 19; alate viviparae on *Pyrus* and *Crataegus* April 28 to June 23 and Sept. 5 to Nov. 4, on *Graminaceae* June 20 to Dec. 26 (in insectary), sexuales on *Pyrus, Crataegus* and *Graminaceae* Oct. 17 to Dec. 9; innumerable collections, very abundant.

Rhopalosiphum pseudobrassicae (Davis).

Davis, Can. Ent., Vol. 46, p. 231, 1914. *Aphis.*

Color.—Viviparae.—Olive-green, yellowish to medium, with lateral areas and in apterae two longitudinal dorsal rows of large spots dusky; all appendages pale to dusky.

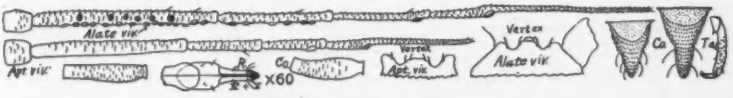


FIG. 200. *Rhop. pseudobrassicae.*

Measurements.—Apterous summer vivipara.—Body .85 to 1.40 mm.; hind tibiae .63 mm.; hind tarsi .11 to .14 mm.; antennae .95 to 1.40 mm.; III .25 to .45 mm.; IV .12 to .22 mm.; V .13 to .17 mm.; VI .11 to .13 + .20 to .30 mm.; cornicles .23 to .25 mm.; cauda .10 mm. hard portion, .14 mm. entire length; rostrum obtuse, joint IV + V .10 mm., attaining 2d. coxae. Alate vivipara.—Body 1.40 mm.; hind tibiae .95 to 1 mm.; hind tarsi .14 to .15 mm.; antennae 1.2 to 1.55 mm.; III .31 to .49 mm.; IV .20 to .33 mm.; V .17 to .24 mm.; VI .11 to .21 + .30 to .40 mm.; cornicles .17 to .21 mm.; cauda .11 mm. hard portion, .17 mm. entire length; rostrum attaining half way between 1st. and 2d. coxae.

Structural Characters.—Vertex strongly convex. Frontal tubercles developed equal with vertex. Secondary sensoria circular, arranged mostly in a single row along almost entire length of joint, 16 to 22 on III, 2 to 6 on IV, 0 on V; absent in apterae. Hairs blunt, sparse, inconspicuous; on vertex, antennae and tibiae .01 to .015 mm. long. Cornicles slightly clavate, with flanges and slightly imbricated. Cauda conical or distal half cylindrical distinctly narrower than basal portion and bearing 2 or 3 hairs on each side. Fore wings with 2d. fork of media .25 to .33 the distance from margin of wing to 1st. fork.

Collections.—On *Brassica Rapa, Roripa nasturtium, Raphanus sativus, Bursa Bursa-pastoris,* and *Matthiola* sp. at Denver,

Loveland, and Fort Collins; alate and apterous viviparae all months of the year; 14 collections, not rare and in many cases very abundant and injurious in late summer and autumn.

Rhopalosiphum rhois Monell.

Monell, Bul. U. S. Geol. and Geog. Surv. Terr., Vol. No. 1, p. 29, 1879.

For fuller description see Davis, Can. Ent., Vol. 46, p. 165, 1914. *Rhopalosiphum howardi* (Wilson).

Color.—Viviparae.—Brownish to greenish-cadmium-yellow; legs dusky to black; cauda concolorous with body; cornicles black.

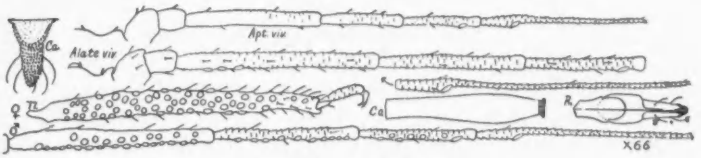


FIG. 201. *Rhop. rhois.*

Measurements.—Apterous summer vivipara.—Body to base of cauda 1.9 to 2 mm.; hind tibiae .80 to .88 mm.; hind tarsi .11 mm.; antennae 1.25 mm.; III .31 to .36 mm.; IV .15 to .23 mm.; V .18 to .22 mm.; VI .10 to .11 + .33 to .40 mm.; cornicles .30 to .38 mm.; cauda .17 mm. hard portion, .21 mm. entire length. Alate vivipara.—Body to base of cauda 1.1 to 1.35 mm.; hind tibiae .90 to .95 mm.; hind tarsi .11 to .12 mm.; antennae 1.40 to 1.50 mm.; III .33 to .45 mm.; IV .24 to .33 mm.; V .23 to .32 mm.; VI .11 to .13 + .47 to .58 mm.; cornicles .28 to .38 mm.; cauda .10 mm. hard portion, .15 mm. entire length; rostrum obtuse, joint IV + V .09 mm. long, attaining between 1st. and 2d. coxae.

Structural Characters.—Vertex slightly convex. Frontal tubercles but slightly developed, not attaining vertex. Secondary sensoria circular, flat, in single row, 2 to 7 on III, 0 on IV and V in alatae, absent in apterae. Hairs slightly capitate; on vertex and antennae .01 mm. long; on tibiae .015 to .02 mm. long; on cauda .04 to .05 mm. long, pointed and curved. Cornicles clavate, width at middle twice hind tibiae, smooth and with flanges. Cauda cylindrical, with slight neck, bearing two hairs on each side and one dorsal at tip. Fore wings with 2d. fork of media .5 or more of the distance from margin of wing to 1st. fork. Oviparae with hind tibiae distinctly swollen on proximal .66 and covered with numerous sensoria. Males alate.

Collections.—On *Rhus trilobata* and *glabra* for winter host and *Elymus canadensis*, *Echinochloa Crusgalli* and sp., *Stipa* sp., barley, oats and timothy as summer hosts, at Trinidad, Manitou, Boulder and Fort Collins; apterous summer viviparae on *Rhus* sp. June 6 to 19 and Aug. 31 to Oct. 12, on grasses July 12 to Aug. 19, alate viviparae on *Rhus* June 30 and Aug. 31

to Oct. 12, on grasses June 23 to Oct. 16, oviparae on *Rhus* Sept. 29; males on grass Oct. 4 to 16; 38 collections, rather common.

Rhopalosiphum rufomaculata (Wilson).

Wilson, Ent. News, Vol. 19, p. 261, 1908. *Aphis.*
Syn. *Stephensonia lahorensis* Das, Mem. Ind. Mus., VI, p. 175, 1918.

Color.—Viviparae.—Light apple-green with dusky to orange specks; cornicles dusky green; apterae with yellow blotches at bases of cornicles; alatae with two dusky dashes caudad of cornicles; venation slightly dusky.

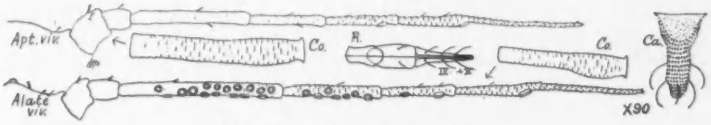


FIG. 202. *Rhop. rufomaculata.*

Measurements.—Apterous vivipara.—Body to base of cauda 1.40 to 1.50 mm.; hind tibiae .55 mm.; hind tarsi .09 mm.; antennae .80 to .95 mm.; III .17 to .23 mm.; IV .13 mm.; V .11 to .12 mm.; VI .11 + .20 mm.; cornicles .27 to .33 mm.; cauda .11 mm. hard portion, .15 mm. entire length; rostrum rather acute, joint IV + V slender, .10 to .12 mm. long, attaining 2d. coxae. Alate vivipara.—Body 1.20 to 1.30 mm.; hind tibiae .65 mm.; antennae .95 to 1.06 mm.; III .23 to .27 mm.; IV .14 to .17 mm.; V .13 to .15 mm.; VI .11 to .13 + .17 to .23 mm.; cornicles .22 to .28 mm.; other measurements as in apterae.

Structural Characters.—Vertex prominent, almost angular. Frontal tubercles rudimentary. Secondary sensoria circular, nearly flat, scattered along nearly entire length of joints, 7 to 13 on III, 6 to 8 on IV, 0 to 3 on V in alatae; absent in apterae. Hairs blunt, .01 mm. on vertex and antennae; on cauda pointed, curved and .03 mm. long. Cornicles slightly clavate, slender, widest portion hardly wider than hind tibiae and with distinct flange. Cauda cylindrical, blunt, with tendency to constriction, bearing two pairs of lateral and a single median hair. Fore wings with 2d. fork of media .33 to .5 of distance from margin of wing to 1st. fork. Prothoracic tubercles present. Sexuales unknown.

Collections.—On *Chrysanthemum* in greenhouses and once on *Artemisia ludoviciana* at Fort Collins; apterous and alate viviparae Oct. 12 to March 10; 20 collections, fairly common.

Taxonomy.—The genus *Coloradoa* was erected by Wilson for this species but the characters, in the opinion of the writers, are sufficient for only subgeneric rank. *Stephensonia lahorensis* Das. 1918, judging from Theobald (Aph. Gr. Brit., Vol. 3, p. 339, 1929), Takahahi (Aph. Form., Pt. 3, p. 39, 1924) and from specimens kindly sent us by D. Hille Ris Lambers from Holland, is a synonym of *rufomaculata* Wilson.

Rhopalosiphum scirpifolii Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 25, No. 1, p. 138, 1932.

Color.—Viviparae.—Dark brown to greenish-black, in apterae lighter laterally and anteriorly; all appendages sordid to dusky, sometimes orange spots at cornicle bases especially in oviparae.

Measurements.—Apterous vivipara.—Body 2 to 2.25 mm.; hind tibiae .85 to 1 mm.; hind tarsi .13 mm.; antennae 1.10 to 1.25 mm.; III .24 to .41 mm.; IV .13 to .24 mm.; V .13 to .24 mm.; VI .09 to .10 + .27 to .39 mm.; cornicles .17 to .18 mm.; cauda .06 mm. hard portion, .12 mm. entire length. Alate vivipara.—Body 1.8 to 2 mm.; hind tibiae 1.05 mm.; hind tarsi .12 mm.; antennae 1.2 to 1.6 mm.; III .35 to .50 mm.; IV .22 to .29 mm.; V .22 to .24 mm.; VI .10 + .32 to .42 mm.; cornicles .14 to .17 mm.; cauda .08 mm. hard portion, .14 mm. entire length; rostrum obtuse with joint IV + V .12 mm., attaining 2d. pair of coxae more or less.

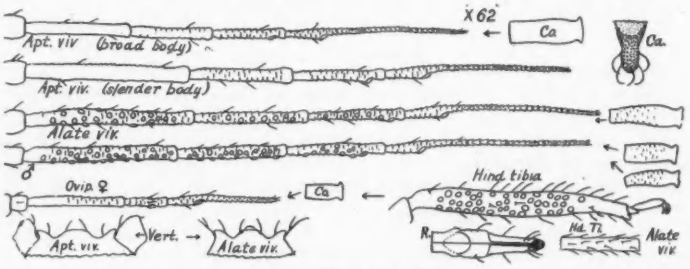


FIG. 203. *Rhop. scirpifolii.*

Structural Characters.—Vertex distinctly convex. Frontal tubercles developed about equal to vertex. Secondary sensoria circular, scattered along most of joints, 16 to 24 on III, 7 to 10 on IV, 1 to 5 on V; absent in apterae. Cornicles slightly incrassate with large flange, faintly imbricated, slightly wider than tibiae. Cauda cylindrical with slight tendency to constriction, blunt, bearing 2 hairs on each side. Hairs pointed; .04 mm. long on vertex and antennae, sparse; .05 mm. and rather numerous on tibiae; on cauda .05 mm. long and curved. Lateral tubercles small, present on prothorax, and abdominal segments 1 and 6. Fore wings with 2d. fork of media .25 to .33 the distance from margin of wing to 1st. fork. Oviparae with hind tibiae slightly swollen for most of length and covered with rather large, flat, round sensoria. Males alate.

Collections.—On leaves and stems of *Prunus Besseyi* as winter host, on *Scirpus campestris* and sp. as summer host at Fort Collins; apterous summer viviparae Sept. 26 to Oct. 29, alate viviparae Oct. 15 to 26, oviparae on *Prunus Besseyi* Nov. 4, males on *Scirpus* and *Prunus* Oct. 7 to Nov. 2; 9 collections, apparently rare.

Types in U. S. Nat. Mus., Cat. No. 43848; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species differs from *R. prunifoliae* Fitch in the considerably shorter cornicles, shorter than antennal IV and the less pronounced flange on cornicles, also cauda shorter than base of antennal VI. In *R. prunifoliae* cornicles are subequal or longer than antennal IV and cauda is longer than base of antennal VI.

Rhopalosiphum serotinae Oestlund.

Oestlund, "Aph. Minn.," Geol. and Nat. Hist. Surv. Minn., Bul. 4, p. 76, 1887.

Color.—All forms.—Pale apple-green; cornicles pale dusky with dark tips; cauda pale brownish; legs pale to dusky; venation heavy.

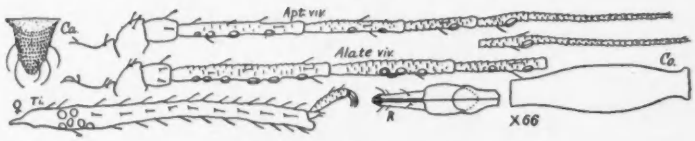


FIG. 204. *Rhop. serotinae.*

Measurements.—Apterous vivipara.—Body 1.50 to 1.90 mm. to base of cauda; hind tibiae .75 to .90 mm.; hind tarsi .10 mm.; antennae 1.15 to 1.30 mm.; III .25 to .29 mm.; IV .19 to .22 mm.; V .15 to .19 mm.; VI .10 to .12 + .29 to .35 mm.; cornicles .37 to .42 mm.; cauda .10 mm. hard portion, .15 mm. entire length; rostrum obtuse, joint IV + V slender, .12 mm., nearly attaining 2d. coxae. Alate vivipara.—Same as aptera except the following: antennae 1.37 mm.; III .25 to .37 mm.; IV .22 to .30 mm.; V .14 to .21 mm.; VI .10 to .11 + .32 to .39 mm.

Structural Characters.—Vertex slightly convex. Frontal tubercles equalling vertex. Secondary sensoria large, with diameter equal to half of antennal joint, arranged in single row, in alate viviparae 6 to 10 on III, 3 to 6 on IV, and 0 to 2 on V; in apterae 2 to 4 on III, 0 to 2 on IV, 0 on V. Hairs blunt; on vertex .02 to .03 mm.; on antennae .01 mm.; on cauda .05 mm.; curved and pointed. Cornicles strongly swollen except at ends, 3 times width of hind tibiae and with swollen flange, smooth. Cauda conical, blunt, bearing 2 pairs of lateral and a single median hair at tip. Oviparae with proximal .33 of hind tibiae slightly swollen and bearing about 6 large sensoria. Males apterous.

Collections.—On *Solidago* sp. at Denver, Boulder and Fort Collins; fundatrices May 17; apterous summer viviparae May 18 to Oct. 2, alate viviparae June 15 to 23, sexuales Oct. 2 to 19; 14 collections, not rare.

Taxonomy.—This species has been made genotype of the genus *Cachryphora* Oestlund. It seems to the writers that the characters are sufficient for a subgenus only.

Genus **Siphonatrophia** Swain.

Swain, Ent. News, Vol. 29, p. 363, 1918.

Characters.—Frontal tubercles rudimentary. Antennae five-jointed in at least fundatrices and oviparae.* Body of apterae strongly arched dorsally, flattened ventrally, hemispherical. Cornicles mere pores. Cauda elongate-conical. Sensoria circular. Fore wings with media twice forked. Hind wings with both media and cubitus. Lateral tubercles not evident.

[Genotype **Siphonatrophia cupressi** (Swain).]

Swain, Trans. Amer. Ent. Soc., Vol. 44, p. 21, 1918. *Cerosipha.*

Color.—Viviparae.—Green, dark in alatae, yellowish in apterae; appendages pale or greenish.

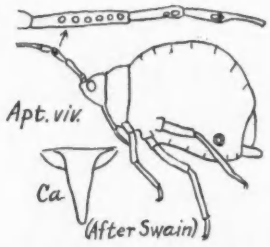


FIG. 205. *Siphonatrophia cupressi.*

Measurements.—Apterous summer vivipara.—Body 1.15 to 1.29 mm.; antennae .51 to .54 mm.; III .136 to .170 mm.; IV .093 to .102 mm.; V .17 to .204 mm.; cauda .187 to .204 mm.; hind tarsi .119 mm.; diameter of cornicle at base .035 mm., diameter of opening .021 mm. Alate viviparae.—Body .986 to 1.27 mm.; antennae .493 to .646 mm.; III .153 to .238 mm.; IV .085 to .127 mm.; V .187 to .204 mm.; cauda .144 to .170 mm.; hind tarsi .102 to .119 mm.

Structural Characters.—Frontal tubercles lacking. Antennae five-segmented in all forms. Secondary sensoria circular in single row; 5 to 8 on III, 1 to 3 on IV, 0 on V; absent in apterae. Rostrum attaining 2d. coxae. Lateral tubercles not evident. Fore wings with 2d. fork nearer to margin of wing than to 1st. fork. Cauda long, ensiform, quite conspicuous, slightly longer than one-eighth of body, one and one-half as long as hind tarsi. Cornicles mere pores, very hard to distinguish. (Data for description from Swains' original description.) Not recorded from the state.

*The 5-jointed antennal character appears to be of minor importance upon consideration of its variability in *S. gravida* (Knowlton). Knowlton's form shows such striking agreement in all other characters except branching of media, that even specific distinction is somewhat uncertain.

Siphonatrophia gravida (Knowlton).

Knowlton, The Fla. Ent., Winter No., p. 60, December 8, 1928. *Minuticornis*.

For further description see also Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 22, p. 12, 1929.

Color.—Viviparae.—Cedar-green; all appendages pale.

Measurements.—Apterous summer vivipara.—Body to base of cauda 1 to 1.7 mm.; hind tibiae .40 to .45 mm.; hind tarsi .11 mm.; antennae .60 mm.; III .12 to .15 mm.; IV .06 to .10 mm., V .08 to .11 mm.; VI .10 + .10 to .12 mm.; cornicles .01 mm.; cauda .12 mm. hard portion, .17 mm. entire length; rostrum rather broadly obtuse, joint IV + V .08 mm. long, attaining 3d. coxae or abdomen. Alate vivipara.—Body 1.1 to 1.6 mm.; hind tibiae .50 to. 55 mm.; hind tarsi .09 mm.; antennae .66 to .75 mm.; III .17 to .21 mm.; IV .10 to .13 mm.; V .11 to .13 mm.; VI .10 + .11 to .13 mm.; cornicles .01 mm.; other measurements as in apterae.

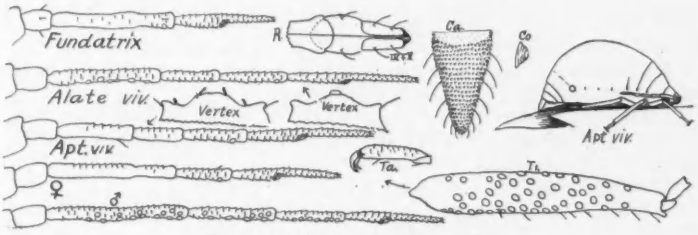


FIG. 206. *Siphonatrophia gravida.*

Structural Characters.—Vertex convex. Frontal tubercles rudimentary. Body of apterae hemispherical, closely appressed to leaf, resembling minute pea, or swelling on leaf. Secondary sensoria circular, arranged in a single row 4 to 9 on III, 1 to 3 on IV in alate viviparae; absent in apterae. Hairs minute or not evident on body, very sparse, on legs .01 mm.; on cauda .03 mm. slightly curved. Cornicles mere pores on conical base, .01 mm. high. Cauda elongate conical, bearing about 7 hairs on each side. Lateral tubercles not evident. Fore wings with mediae one-branched. Hind wings with both media and cubitus. Oviparae with hind tibiae strongly swollen and bearing large sensoria throughout entire length. Males alate or apterous.

Collections.—On leaves of *Sabina scopulorum*, solitary, at Fort Collins; fundatrices April 21, apterous summer viviparae May 9 to Sept. 25, alate viviparae May 9 and Aug. 8, oviparae Oct. 11 and Nov. 6, males apterous Nov. 6, alate Oct. 11; 6 collections, probably common but quite difficult to find due to protective coloration, appressed position and solitary habit.

Taxonomy.—This species is separated from *Siphonatrophia cupressi* (Swain) only by the six-jointed antennae in alate and

apterous summer viviparae and the once-branched mediae of fore wings.

Genus **Toxoptera** Koch.

Koch, Die Pflanz. Aphiden, p. 253, 1857.

Characters.—Same as for genus *Aphis* except fore wings with media only once-forked.

Genotype, *Toxoptera aurantiae* Koch (*aurantiae* Boyer).

KEY TO SPECIES OF TOXOPTERA.

A. Cornicles hardly as wide as hind tibiae, without reddish blotches about bases. (Page 494).....**graminum**
AA. Cornicles slightly wider than hind tibiae, with reddish blotches about bases. (Page 495).....**viridi-rubra**

Toxoptera graminum (Rondani).

Rondani, Nuov. Ann. Sci. Nat. Rend., Ser. 3, VI, p. 10, 1852. *Aphis.*

For fuller description see Pergande, U. S. D. A. Bul. 38, p. 7, 1902, and Webster and Phillips, U. S. D. A., Bur. Ent., Bul. 110, p. 1, 1912.

Color.—All forms.—Pale yellowish-green with darker green longitudinal streaks medially and laterally; cauda pale; antennae dusky; legs and cornicles pale with dusky tips.

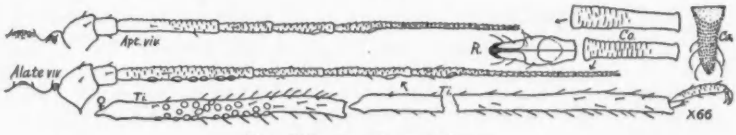


FIG. 207. *Toxop. graminum.*

Measurements.—Apterous vivipara.—Body to base of cauda 1.35 mm. to 2 mm.; hind tibiae .45 to .85 mm.; hind tarsi .10 mm.; antennae .75 to 1.15 mm.; III .18 to .28 mm.; IV .11 to .18 mm.; V .10 to .17 mm.; VI .08 to .10 + .26 to .37 mm.; cornicles .18 to .27 mm.; cauda .13 mm. hard portion, .17 mm. entire length; rostrum broadly obtuse, joint IV + V .08 mm. long, attaining between 1st. and 2d. coxae. Alate vivipara.—Body 1.40 to 1.70 mm.; hind tibiae .70 to .95 mm.; hind tarsi .10 to .12 mm.; antennae 1.1 to 1.3 mm.; III .27 to .36 mm.; IV .19 to .27 mm.; V .17 to .24 mm.; VI .10 to .12 + .30 to .50 mm.; cornicles .19 to .24 mm.; cauda and rostrum as in apterae.

Structural Characters.—Vertex distinctly convex. Frontal tubercles developed equal to vertex and in apterae bearing short finger-like processes on ventral surface. Secondary sensoria circular, arranged in single row, 5 to 8 on III, and 0 to 1 on IV in alate viviparae. Hairs pointed, .015 to .02 mm. long on vertex, antennae and outer side of tibiae, sparse. Cornicles cylindrical, rather slender, with slight flange, proximal half with transverse wrinkles. Cauda elongate-conical,

bearing two pairs of lateral hairs. Lateral tubercles developed on prothorax and 1st. and 7th. abdominal segments. Fore wings with media once branched; hind wings with media and cubitus present. Oviparae with hind tibiae but slightly swollen on middle half and bearing about 23 rather large flat sensoria. Males alate.

Collections.—On wheat, oats, barley and *Agropyron* sp., throughout the eastern part of the state; apterous summer vivipara April 2 to Aug. 24, alate vivipara April 2 to Oct. 30, sexuales Oct. 17 to 24; 29 collections, common, often in injurious numbers.

Toxoptera viridi-rubra Gillette and Palmer.

Gillette and Palmer, Ann. Ent. Soc. Amer., Vol. 25, p. 136, 1932.

Color.—Viviparae.—Reddish-brown or olive-green with orange stain about and between cornicle bases; alatae with dusky lateral areas; cauda pale; cornicles black; legs mostly pale yellow.

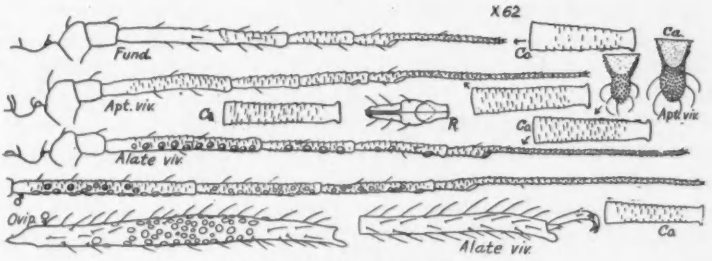


FIG. 208. *Toxop. viridi-rubra.*

Measurements.—Alate vivipara.—Body 1.1 to 2 mm.; hind tibiae .77 to .90 mm., hind tarsi .09 mm.; antennae 1.4 to 1.5 mm.; III .36 to .42 mm.; IV .20 to .25 mm.; V .21 to .23 mm.; VI .10 + .44 to .50 mm.; cornicles .26 mm.; cauda .08 mm. hard portion, .13 mm. entire length; rostrum rather broadly obtuse, joint IV + V .09 mm. long, attaining nearly to 2d. coxae. Apterous summer vivipara.—Body 2 mm. by 1.25 mm.; hind tibiae .80 mm.; hind tarsi .09 mm.; antennae 1.35 mm.; III .30 to .33 mm.; IV .17 to .25 mm.; V .11 to .19 mm.; VI .09 + .40 to .45 mm.; cornicles .25 to .30 mm.; cauda .09 mm. hard portion, .12 mm. entire length; rostrum as in alata.

Structural Characters.—Vertex slightly convex. Frontal tubercles exceeding vertex by .02 mm.; in apterae bearing rudimentary finger-like projection. Secondary sensoria circular, flat, arranged in single row along almost entire length of joint, 6 to 11 on III, 3 to 5 on IV, 0 to 2 on V; absent in apterae. Hairs on vertex slightly capitate .02 to .025 mm. long in alatae, .03 to .04 mm. in apterae; on antennae pointed, .015 mm. long; on outer side of middle of hind tibiae .05 to

.06 mm. long in alatae, .07 to .10 mm. in apterae; longer than diameter of tibia; on cauda curved and .05 to .06 mm. long. Cornicles cylindrical with tendency to constriction next to distinct flange, imbricated, at least same width as hind tibiae or slightly wider. Cauda blunt, cylindrical, with slight neck, bearing 2 pairs of lateral hairs and a single dorsal hair at tip. Lateral tubercles evident on prothorax and all abdominal segments except 5th. and 8th. Ocular tubercles present. Fore wings with mediae once-branched; hind wings with both media and cubitus. Oviparae with hind tibiae somewhat swollen in middle and rather thickly covered with irregular-sized, nearly flat sensoria on middle half. Males alate.

Collections.—On leaves and stems of *Carex nebraskensis;* near Fort Collins; fundatrices April 26; apterous summer viviparae May 12 to Nov. 9, alate viviparae May 12 and 17, apterous oviparae Nov. 9 to 13, alate males Nov. 9 to 23; 6 collections, apparently not abundant.

Types in collection of U. S. Nat. Mus., Cat. No. 43847; paratypes in collection of Colo. Agr. Exp. Sta.

Taxonomy.—This species differs from *Toxoptera graminum* Rondani in color of body, being darker green and reddish at least about cornicles; in spoon-shaped cauda; more robust cornicles usually slightly wider than hind tibiae. From *Toxoptera caricis* Fullaway this form differs in shorter and more cylindrical cornicles, unguis longer than III and spoon-shaped cauda. From *Toxoptera nigra* Baker it differs in body not black and antennal III always at least .75 of unguis and always longer than cornicles, even in apterae.

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'20. Baird, A. B., 228 Dundas St. E., Belleville, Ontario, Canada. *Parasitic Hymenoptera.*
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'13. Bilsing, S. W., College Station, Texas. *Cerambycidae, Acrididae.*
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'26. Bird, Ralph D., Univ. Okla., Norman, Okla. *Odonata.*
Ch. BISHOPP, F. C., Bur. Ent., Washington, D. C. (F. '28). *Ixodoidae, Siphonaptera, Anopleura.*
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'17. Bowers, H. L., 31 N. Eastfield Ave., Trenton, New Jersey.
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'23. Branch, Hazel E., 3756 East Douglas Ave., Wichita, Kansas. *Chironomidae larvae.*
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'27. Brunson, M. H., Box H, Moorestown, N. J. *Truck Insects.*
'20. Bryan, Edwin H., Jr., Bishop Museum, Honolulu, Hawaii. *Hawaiian Diptera.*
'30. Bryant, Owen, Box R, Banff, Alberta, Canada.
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'27. Buckell, Edward R., Box 308, Vernon, Brit. Col., Canada. *Orthoptera.*
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'30. Caler, H. L., Box 12, Addison, Maine.
Ch. CALVERT, PHILIP P., Zool. Lab., Univ. of Pa., Phila., Pa. (F. '07). *Odonata.*
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'28. Campbell, Frank Leslie, 7710 Blair Rd., Takoma Park, Md. *Toxicology.*
'13. Campbell, Roy E., P. O. Box 297, Alhambra, Calif. *Syrphidae.*
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'10. COOLEY, R. A., U. S. Public Health Service, Hamilton, Mont. (F. '24). *Ixodidae, Ixodiphiginee.*
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'27. Craig, F. Waldo, 1634 Franklin Ave., Charleston, W. Va. *Cicadellidae.*

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'22. Davis, Edgar W., 601 McCornick Bldg., Salt Lake City, Utah. *Cicadellidae.*
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'29. DeLeon, Donald, 59 Carmine St., New York, N. Y. *Scolytidae.*
'14. DELONG, D. M., Dept. Ent., Ohio St. Univ., Columbus, Ohio. (F. '30). *Cicadellidae.*
'31. Denis, G. R., Laboratoire Arago, Banyuls-sur-Mer (Pyr-Or), France. *Apterygota.*
'20. Detwiler, John D., Dept. Zoo., Univ. Western Ont., London, Ontario, Canada. *Corn Borer Prob.*
'27. Dicke, Ferdinand F., Box 592, Charlottesville, Va. *Harmolita Parasites.*
'22. Dietrich, Henry, St. Plant Bd., Lucedale, Miss. *Coleoptera.*
Ch. Dietz, Wm. G., 21 N. Vine St., Hazleton, Pa. *Coleoptera, Diptera.*
'24. Dills, L. E., Exp. Sta. Bldg., State College, Pa.
'26. Dirks, C. O., Dept. Bot. and Ent., Orono, Maine.
'31. Ditman, L. P., Univ. of Maryland, College Park, Md. *Hemiptera, Hymenoptera.*
'27. *Doak, K. D., Dept. Bot., Univ. Pa., Phila., Pa. *Gelechiidae.*
Ch. DOANE, R. W., Stanford Univ., Calif. (F. '24).
'28. Dobbins, Traber, N., Bay Springs, Miss. *Pecan Phylloxera.*
'29. Dobroscky, Irene D., 158 A Uluniu Ave., Honolulu, T. H. *Cicadellidae.*
'28. Dodd, Fred O., R. F. D. 5, Paris, Ill.
'22. Doering, Kathleen, C., Dept. Ent., Univ. of Kans., Lawrence, Kan. *Homoptera.*
'22. Dohanian, S. M., 42 Cedar St., West Somerville, Mass. *Parasitic Hymenoptera.*
'28. Doner, Melvin H., Dept. Ent., U. of Wis., Madison, Wis. *Lepidoptera.*
'31. Donohoe, Heber C., 712 Elizabeth, Fresno, Calif. *Pyralidae.*

'30. Dornfeld, Ernest J., 212 E. North Ave., Milwaukee, Wis. *Haploa, Hymenoptera.*
'29. Dorst, Howard E., 601 McCornick, Bldg., Salt Lake City, Utah. *Cicadellidae.*
'30. Dotterrer, Dorothy C., R. F. D. 1, Verona Road, Verona, Pa. *Coleoptera.*
'22. Doucette, Charles F., Box 566, Sumner, Wash. *Ornamental Insects.*
'31. Douglas, Raymond E., 302 Bryant Ave., Ithaca, N. Y. *Coccidae.*
'23. Douglass, J. R., Box 353, Estancia, N. Mex. *Chrysomelidae.*
'28. Douglass, Nelson L., Box 613, Grenada, Miss.
'28. Dove, W. E., Box 324, Charleston, South Carolina. *Animal Parasites.*
'28. Dove, W. H., Cia Carbonifera de Sabinas S. A., Rosita, Coahuila, Mexico. *Scale Insects and Parasites.*
'31. Dow, Richard P., 12 Andover Hall, Cambridge, Mass. *Sphecidae, Vespoidea.*
'22. Dowden, Philip B., 1156 Main St., Melrose Highlands, Mass. *Parasitic Hymenoptera.*
'17. Dowell, Philip, 86 Bond St., Port Richmond, N. Y.
'25. Dozier, Herbert L., Div. of Insects, U. S. Nat. Museum, Washington, D. C. *Homoptera.*
'22. DRAKE, CARL J., Iowa St. College, Ames, Ia. (F. '31). *Tingitidae.*
'31. Driggers, Byrley F., Agr. Exp. Sta., New Brunswick, N. J. *Economic Entomology.*
'26. Dunavan, David, Clemson College, So. Carolina. *Coleoptera, Carabidae.*
'23. Duncan, Carl D., Box 4, Stanford Univ., Calif. *Vespidae, Bembicidae.*
'30. Dunn, Lawrence H., c/o Gorgas Mem. Lab., Box 5025, Ancon, Canal Zone. *Ticks, Culicidae, Tabanidae.*
'28. Dunnam, E. W., Box 750, Bryan, Texas. *Cotton Insects.*
'16. DuPorte, E. Melville, Macdonald College, Quebec, Canada. *Diptera, Ixodoidea.*
'14. Dusham, E. H., Dept. Zool. and Ent., State College, Pa. *Coleoptera.*

'29. Eagleson, Craig W., Dept. Ent., Ohio St. Univ., Columbus, Ohio. *Insect Physiology.*
Ch. Easton, Norman S., 458 High St., Fall River, Mass. *Coleoptera.*
'25. Eaton, Theodore H. Jr., International House, Berkeley, Calif. *Lepidoptera.*
'31. Eckert, J. E., Box 381, Davis, Calif.
'23. Eddy, C. O., Agr. Exp. Sta., Lexington, Ky.
Ch. Edwards, Edwin H., 1548 Rockway Ave., Lakewood, Ohio. *Coleoptera.*
'31. Elliott, Clements, Dept. Zool. and Ent., Baton Rouge, La.
'24. Elmore, J. C., Box 294, Alhambra, Calif. *Coleopterous Larvae.*
'17. Elrod, Morton J., State Univ., Missoula, Mont.
'27. Elson, J. A., Gustavus Adolphus College, St. Peter, Minn. *Hemiptera.*
'11. Ely, Chas. R., 6 Kendall Green, Washington, D. C. *Gracilariidae.*
'19. Emerson, Alfred E., Dept. Zool., Univ. of Chicago, Chicago, Ill. *Isoptera, Termitophilas.*
'14. Enburg, John M., 5141 Baltimore Ave., Philadelphia, Pa.
'25. Enders, Howard E., 249 Littleton St., West Lafayette, Ind. *Mallophaga.*
Ch. Engelhardt, George P., 28 Club Way, Hartsdale, N. Y. *Aegeriidae.*
'25. English, L. L., Spring Hill, Ala.
'22. Esaki, Teiso, Ent. Lab., Dept. Agr., Kyushu Imperial Univ., Fukuoka, Japan. *Heteroptera.*
'10. ESSIG, E. O., Univ. of Calif., Berkeley, Calif. (F. '26). *Aphididae, Coccidae.*
'29. Evans, John H., Oshkosh High School, Oshkosh, Wis. *Membracidae.*
'29. Evans, Neal E., Dept. Zool., Marquette Univ., Milwaukee, Wis. *Hemiptera.*
'30. Everly, Ray T., 615 Front St., Toledo, Ohio. *Carabidae.*
Ch. Ewers, Lt. Col. Wm. V., Les Revenants, Somerset, Bermuda.
'10. EWING, HENRY E., U. S. Nat. Mus., Washington, D. C. (F. '28). *Acarina.*
'18. Eyer, John R., State College, New Mexico. *Microlepidoptera.*

Ch. FALL, HENRY C., Tyngsboro, Mass. (F. '07). *Coleoptera.*
'30. Farmer, Lowell J., Moscow, Idaho.
'30. Farquhar, Donald W., 296 Ames St., Lawrence, Mass. *Lepidoptera of New England.*

'31. Farrar, M. D., State Ent. Bldg., Urbana, Ill.
'17. Fattig, P. W., Box 788, Emory University, Ga.
Ch. FELT, E. P., Bartlett Tree Research Lab's., Stamford, Conn. (F. '08). *Itonididae.*
'30. Feng, Hsiao-Tang, Dept. Entomology, Cornell Univ., Ithaca, N. Y. *Dytiscidae.*
'15. Fenton, F. A., Box 67, Station A., El Paso, Texas. *Dryinidae.*
Ch. FERNALD, H. T., 707 East Concord Ave., Orlando, Fla. (F. '14). *Sphecidae.*
'14. Ferris, G. F., Stanford University, Calif. *Coccidae, Mallophaga, Anoplura, Diptera.*
'27. Ficht, George A., Box 359, Monroe, Mich.
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'31. Filmer, Robert Sterling, Ent. Bldg. Rutgers Univ., New Brunswick, N. J. *Insecticides, Bees.*
'10. Fink, David E., 7710 Blair Rd. Takoma Park, Md. *Insect Physiology.*
'27. Fisher, C. K., Box 24, Modesto, Calif.
'07. Fisher, W. S., U. S. Nat. Mus., Washington, D. C. *Cerambycidae, Buprestidae*
'30. Flanders, Stanley E., Citrus Exp. Sta., Riverside, Calif.
'31. Fletcher, Fred W., Dept. Forest Ent., Syracuse Univ., Syracuse, N. Y. *Homoptera, Cicadellidae.*
'19. Fletcher, Robert K., Box 152 Faculty Exch., College Station, Texas. *Cicadellidae, Cicindelidae.*
'08. FLINT, WESLEY P., St. Ent. Bldg., Urbana, Ill. (F. '31). *Economic Entomology.*
'19. Florence, Laura, 445 East 65th St., Apt. 30, New York City. *Anoplura.*
'24. Fluke, C. L., 1532 Univ. Ave., Madison, Wis.
Ch. FOLSOM, J. W., Delta Lab., Tallulah, La. (F. '07). *Collembola, Thysanura.*
'08. *FORBES, WM. T. M., Roberts Hall, Cornell U., Ithaca, N. Y. (F. '30). *Lepidoptera, Neuropteroids.*
'30. Foster, Charles E., Colgate Univ., Hamilton, N. Y. *Coccidae.*
'20. *Fournier, Mrs. Gaston, 90 Boul. Malesherbes, Paris 8, France. *Lepidoptera.*
'25. Fouts, Robert, 357 N. Harper Ave., Hollywood, Cal. *Hymenoptera, Serphoidea.*
'31. Fox, David E., Box 1100, Twin Falls, Idaho. *Membracidae, Pipunculidae.*
'12. Fox, Henry, Jap. Beetle Lab., Moorestown, N. J. *Orthoptera, Scarabaeidae.*
'11. Fracker, S. B., Federal Horticultural Bd., Washington, D. C. *Coreidae.*
'23. Freeborn, Stanley B., Univ. Farm, Davis, Calif. *Culicidae.*
'22. Friend, Roger B., Agri. Exp. Sta., 153 Huntington St., New Haven, Conn. *Diptera.*
'14. FRISON, T. H., Nat. Hist. Bldg., Univ. Ill., Urbana, Ill. (F. '29). *Bremidae.*
Ch. Frost, C. A., 67 Henry St., Framingham, Mass. *Coleoptera.*
'14. Frost, Stuart W., Arendtsville, Pa. *Agromyzidae, Phytomyza.*
Ch. Fullaway, D. T., Board of Agr., Box 3319, Honolulu, Hawaii. *Braconidae.*
'16. Fulton, B. B., State College, Raleigh, North Carolina. *Orthoptera.*
'11. FUNKHOUSER, WM. D., Univ. of Ky., Lexington, Ky. (F. '20). *Membracidae.*

Ch. GAHAN, A. B., U. S. Nat. Mus., Washington, D. C. (F. '28). *Chalcidoidea, Braconidae.*
'28. Gahm, O. E., Chester Co. Mushroom Lab., West Chester, Pa. *Mushroom Pests.*
'16. Gaige, F. M., Mus. of Zool., Univ. of Mich., Ann Arbor, Mich. *Formicidae.*
'28. Gamble, John T., 64 Eagle St., Greenville, Pa. *Aquatic Coleoptera.*
'22. Garlick, W. G. P., Vineland Station, Ontario, Canada. *Tenthredinoidea.*
'14. Garman, Philip, Agr. Exp. Sta., New Haven, Conn. *Odonata, Acarina.*
'28. Garrison, Gwynn L., Tallulah, La.
'22. Gehring, John George, Bethel, Maine. *Coleoptera.*
'30. Geissler, George H., 34 Swan Street, Lawrence, Mass.
'28. Geist, R. M., Dept. Biol., Capital Univ., Columbus, Ohio. *Mallophaga.*
'16. Gentner, Louis G., 1122 E. Main St., Medford, Oregon. *Halticinae, Coleoptera.*
Ch. Gerhard, Wm. J., Field Mus. Nat. Hist., Chicago, Ill. *Hemiptera.*
'22. Gerry, Bertram I., 7 Howard Ave., Peabody, Mass.

Ch. GIBSON, ARTHUR, Dominion Entomologist, Ottawa, Canada. (F. '17).
'30. Gillespie, A. M., Box 234, Bar Harbor, Maine.
Ch. GILLETTE, C. P., Agr. College, Fort Collins, Colo. (F. '07). *Aphididae.*
'28. Gilliatt, F. C., Ent. Lab., Annapolis Royal, Nova Scotia. *Tortricidae.*
'21. Gilmer, Paul M., 2303 W. Douglas Ave., Wichita, Kansas.
'16. Glaser, R. W., Rockefeller Med. Res. Inst., Princeton, N. J. *Insect Diseases.*
'11. Glasgow, Hugh, Exp. Station, Geneva, New York.
'11. Glasgow, Robert D., State Education Bldg., Albany, N. Y. *Phyllophaga.*
'21. Good, Henry G., Ala. Poly. Inst., Auburn, Ala. *Coleoptera.*
'30. Good, Newell E., 1104 Vermont Ave., Washington, D. C. *Silvanidae, Dermestidae, Ulominae.*
'31. Gould, George E., Agr. Exp. Sta., Purdue Univ., Lafayette, Ind. *Rhagovelia, Semi-Aquatic Hemiptera.*
Ch. Graenicher, S., Box 14, South Miami, Fla. *Aculeata, Muscoidea.*
'17. Graham, Samuel A., Sch. of Forestry, U. of Mich., Ann Arbor, Mich. *Forest Insects.*
'22. Granovsky, A., Div. Ent., Univ. Farm, St. Paul, Minn. *Aphodiae.*
'25. Grant. U. S. IV., Nat. Hist. Mus., Balboa Park, San Diego, Calif.
'27. Gray, John, College of Agr., Gainesville, Fla. *Embryology.*
'14. Greene, Chas. T., College Park, Box 182, Maryland. *Diptera.*
'24. Greer, A. H., Room 6, Federal Bldg., El Paso, Texas. *Heterocera, Culicidae.*
'28. Grimes, D. W., Box 125, Durant, Miss.
'20. Griswold, Grace H., Dept. Ent., Cornell Univ., Ithaca, N. Y.
'24. Gui, Harry L., Agr., Exp. Sta. Wooster, Ohio.
'29. Guthrie, Howard E., 139 N. Sheldon St., Ames, Ia. *Coccidae.*
'21. Guyton, F. E., Auburn, Ala. *Cicadellidae.*
'16. Guyton, T. L., Bur. Plant Industry, Dept. Agr., Harrisburg, Pa. *Aphididae.*

'30. Haas, Louise, Dept. Zool., Iowa State College, Ames, Ia.
'25. Haber, Vernon R., 355 West Ridge Ave., State College, Pa. *Blattidae.*
'27. *Hadden, Fred C., Box 411, Honolulu, Hawaii. *Histeridae, Cicindelidae.*
'23. Hadley, C. H., Bur. Ent., Moorestown, N. J.
'30. Haegele, Rowland W., Ent. Field Sta., Parma, Idaho. *Cicadellidae.*
'24. Haeussler, Gilbert J., c/o American Consulate, Yokohama, Japan.
'14. Hagan, Harold R., Wahiawa via Honolulu, T. H.
'29. Haines, Kenneth A., Dept. Ent., Ohio St. Univ., Columbus, Ohio.
'25. Hall, David G., P. O. Box 324, Charleston, S. Carolina. *Sarcophagidae, Diptera.*
'22. Hall, Maurice C., Bur. Animal Industry, Dept. Agr., Washington, D. C. *Parasites of Domestic Animals.*
'14. Hallinen, J. E., Coopertown, Okla.
'21. Hallock, Harold C., Box 764, Westbury, N. Y. *Diptera, Scarabidae.*
'14. Hamilton, Clyde C., Rutgers College, Dept. Ent., New Brunswick, N. J.
'16. Hamlin, John C., 473 Fourth Ave., Salt Lake City, Utah. *Chelinidea.*
'22. Hamner, Al, Box 203, A. & M. College, Miss. *Aphididae, Phylloxera.*
Ch. Hansen, James, St. Johns Univ., Collegeville, Minn.
'31. Harding, Mrs. Leone, Prattsville, Arkansas. *Cicadellidae.*
'30. Hardy, Christine N., Dept. Ent., Cornell U., Ithaca, N. Y. *Ephemeridae, Odonata, Trichoptera.*
'07. *HARNED, R. W., Bur. Ent., U. S. D. A., Washington, D. C. (F. '27).
'29. Harries, F. H., U. S. Bur. Ent., Twin Falls, Idaho.
'23. Harris, Halbert M., Dept. Zool. and Ent., Iowa St. College, Ames, Ia. *Hemiptera.*
'28. Harris, J. P., 12546 Cedar Rd., Cleveland, Ohio.
'27. Harrison, P. K., Exp. Sta., Baton Rouge, La.
'24. Hart, Cecil, 132 North 3rd. St., Montebello, Calif.
'21. Hartzell, Albert, 1086 N. Broadway, Yonkers, N. Y. *Cicadellidae.*
'07. Hartzell, F. Z., Agr. Exp. Sta., Geneva, N. Y. *Coleoptera.*
Ch. Haseman, Leonard, Univ. of Mo., Columbia, Mo. *Psychodidae.*
'20. Hatch, Melville H., Dept. Zool., Univ. of Wash., Seattle, Wash. *Coleoptera.*
'29. Hatfield, Nicholas W., 3302 E. Fall Creek Blvd., Indianapolis, Ind.
'32. Haub, James G., 36 West Lane Ave., Columbus, Ohio.

'30. Haug, Gordon W., Bot. & Zool. Bldg., Ohio St. Univ., Columbus, Ohio. *Formicidae.*
'27. Hawkins, J. H., Agr. Exp. Sta., Orono, Maine. *Eluterid and Noctuid Larvae.*
'30. Hayden, Helen, 806 E. Senaca St., Ithaca, N. Y.
'19. HAYES, WM. P., Dept. Ent., Univ. Ill., Urbana, Ill. (F. '29). *Larvae.*
Ch. HEADLEE, THOMAS J., Agr. Exp. Sta., New Brunswick, N. J. (F. '20).
'27. Hearle, Eric, Dom. Ent. Lab., Kamloop, Brit. Col. Canada. *Biting Flies.*
'31. Heaton, Robert R., Rushville, Ind. *Fulgoridae, Homoptera.*
'31. Henderson, Lyman S., 710 Ninth Ave., Leavenworth, Kansas.
'26. Hendrickson, George O., Dept. Zool. & Ent., Ia. St. College, Ames, Ia. *Ecology.*
'28. Henneberry, T. V., 75 School St., Manchester, Mass.
Ch. HENSHAW, SAMUEL, 28 Fayerweather St., Cambridge, Mass. (F. '07).
'29. Hering, Paul E., Dept. Ent., Cornell Univ., Ithaca, N. Y. *Economic Entomology.*
'25. HERMS, WM. B., Agr. Hall, Univ. Calif., Berkeley, Calif. (F. '29). *Med. Entomology.*
'29. Herr, Edgar A., Agr. Exp. Sta., Wooster, Ohio. *Thysanoptera.*
Ch. HERRICK, GLENN W., 219 Kelvin Place, Ithaca, N. Y. (F. '14). *Thysanoptera, Coccidae.*
'17. Hertzog, P. H., Highstown, N. J.
'16. Hess, Walter N., Hamilton College, Clinton, N. Y.
'31. Hetrick, Lawrence A., Jr., Box 376, La. St. Univ., Baton Rouge, La. *Coleoptera, Hemiptera.*
'08. Heywood, Mrs. R. E., The Oaks, Peterson, Iowa. *Odonata.*
'28. Hickman, J. R., Normal College, Upsilanti, Mich. *Haliplidae.*
'30. Hicks, Chas. H., 823 Harvard Rd., Burbank, Calif. *Triepeolus, Epeolus.*
'29. Hiestand, Wm. A., Dept. Biol., Purdue Univ., W. Lafayette, Ind. *Coleoptera.*
'30. Hill, Sam O., 10 Court St., Arlington, Mass.
'08. Hilton, Wm. A., 1263 Dartmouth Ave., Claremont, Calif. *Compodea, Japyx.*
'28. Hiltz, J. R., 95 Oakland Ave., Pontiac, Mich.
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'27. Hinman, E. Harold, Dept. Trop. Med., Tulane Med. Sch., New Orleans, La. *Culicidae.*
'27. Hockenyos, Geo. L., 1003 Oregon St., Urbana, Ill.
Ch. Hodgkiss, H. E., Exp. Sta. Bldg., State College, Pa. *Eriophyidae.*
'29. Hodson, Alexander C., Zool. Dept., Univ. Minn., Minneapolis, Minn. *Trichoptera.*
'29. Hodson, Elmer C., 48 Sherwood St., Roslindale, Mass.
'29. Hoffman, Clarence H., Div. Ent., Univ. Farm, St. Paul, Minn. *Scarabaeidae.*
'14. *Hoffman, W. A., Sch. Trop. Med., San Juan, Porto Rico. *Biting Flies.*
'20. Hoffman, Wm. E., Lingnan Univ., Canton, China. *Hemiptera.*
Ch. HOLLAND, W. J., Carnegie Mus., Pittsburgh, Pa. (F. '07, HF. '32). *Lepidoptera.*
'30. Hollingsworth, Wm. B., Box 415, Picayune, Miss.
'13. Holloway, T. E., 8203 Oak St., New Orleans, La.
'12. Hood, Clifford E., Melrose Highlands, Mass.
Ch. Hood, J. Douglas, Dept. Biol., Univ. of Rochester, Rochester, N. Y. *Thysanoptera.*
'27. Hopping, Ralph, Box 308, Vernon, Brit. Col., Canada. *Timber Insects.*
'13. Horton, J. R., 128 So. Minneapolis Ave., Wichita, Kansas. *Ants, Phyllophaga, Tenebrionidae.*
'23. Hottes, F. C., James Millikin Univ., Decatur, Ill. *Aphididae.*
'24. Hough, W. S., Winchester, Virginia. *Apple Insects.*
Ch. HOUSER, J. S., Agr. Exp. Sta., Wooster, Ohio. (F. '31). *Economic Entomology.*
Ch. Howard, Chas. T., 36 Colby St., Rochester, N. Y. *Lepidoptera.*
Ch. HOWARD, L. O., Bur. Ent., Washington, D. C. (F. '07, H. F. '24). *Chalcidoidea.*
'14. Howard, Neale F., 151 West 11th Ave., Columbus, Ohio. *Mex. Bean Beetle.*
'31. Howe, Edwin W., Box 144, Fairfax, South Carolina. *Diptera, Trypetidae, Ortalidae.*

'30. Hsu, Yin-chi, Dept. Ent., Cornell Univ., Ithaca, N. Y. *Gryllidae, Ephemerida.*
'21. Huber, L. L., 1150 N. Bruer St., Wooster, Ohio. *Chalcidoidea.*
'20. Huckett, H. C., Long Is. Vegetable Research Farm, Riverhead, Long Island, N. Y. *Muscidae.*
'27. Hudson, H. F., Dom. Ent. Lab., Strathroy, Ontario, Canada. *Noctuidae.*
'30. Hughes, G. F., Dept. Ent., Cornell Univ., Ithaca, N. Y. *Morphology.*
'09. Hungate, J. W., St. Normal School, Cheney, Washington.
'16. HUNGERFORD, H. B., Dept. Ent., Univ. of Kans., Lawrence, Kans. (F. '27). *Aqatic Hemiptera.*
Ch. HUNTER, S. J., 1145 West Campus Rd., Lawrence, Kansas. (F. '21).
'30. Hutchins, Ross E., A. & M. College, Miss. *Lepidoptera.*
'25. Hutchison, Wilber L., 93 N. Church St., Hazelton, Pa. *Coleoptera.*
'08. Hyslop, James A., Silver Spring, Maryland. *Elateridae.*

'31. Ide, F. P., Dept. Biol., Univ. of Toronto, Toronto 5, Ont., Canada. *Ephemeroptera.*
'11. *Illingworth, J. F., Bishop Mus., Honolulu, Hawaii. *Muscoidea.*
'28. Inaba, Naomichi, 207 Harajiku, Akasaka, Tokyo, Japan. *Lepidoptera.*
'28. Ingram, J. W., Houma, La.
'25. Irish, H. C., 911 Locust St., St. Louis, Mo.
'14. Isley, Dwight, 3 North Ducan St., Fayetteville, Ark. *Chrysomelidae, Curculionidae.*
'22. Ishimori, Naoto, Faculty of Agr., Imp. Univ., Komaba near Tokyo, Japan. *Lepidoptera.*
'27. Ives, J. D., 938 Elm St., New Haven, Conn. *Cave Insects.*

'15. Jackson, L. O., High Sch., Colorado Springs, Colo. *Hymenoptera.*
'28. Jahn, Lydia A., Lindenwood College, St. Charles, Mo. *Syrphids.*
'31. James, Maurice T., 945 22nd St., Boulder, Colo.
'30. Janes, Melvin J., Agr. Exp. Sta., Logan, Utah.
'30. Jaynes, H. A., Casilla Correo 307, Trujillo, Peru, S. A. *Tiphia of S. A.*
'25. JEANNEL, RENE, Mus. d'Histoire Naturelle, 45 bis rue de Buffon, Paris 5e, France. (F. '30). *Trechus, Anophthalmes.*
'10. Jennings, H. R., High School of Com., Hayes & Van Ness Ave., San Francisco, California. *Diptera.*
'15. Jewett, H. H., Agr. Exp. Sta., Lexington, Ky.
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'25. Johnson, Frank, 420 Lexington Ave., New York, N. Y.
'31. Johnston, Clyde H., Box 542, Univ. Sta., Baton Rouge, La.
'26. Johnston, H. G., Ent. Dept., College Station, Texas. *Meridae, Hemiptera.*
'25. Jones, D. W., 10 Court St., Arlington, Mass. *Tachinidae.*
'29. Jones, Edward W., Box 616, Walla Walla, Washington. *Elateridae.*
'27. Jones, Elmer T., 128 S. Minneapolis, Wichita, Kansas.
Ch. Jones, Frank M., 2000 Riverview Ave., Wilmington, Dela. *Psychidae.*
'28. Jones, Luther G., Drawer 359, Monroe, Mich.
'28. Jones, R. M., Science Building, Ames, Iowa.
'30. Jones, S. E., Agr. Exp. Sta., College Station, Texas. *Tenebroinidae.*
'25. Jones, W. Russell, R. F. D. 11, Box 63-B, Pensacola, Fla.

'16. Kahl, Hugo, Carnegie Mus., Pittsburgh, Pa. *Odonata.*
'26. Kamal, Mohammed, Cotton Research Bd., Giza, Egypt. *Syrphidae, Coccidae.*
'30. Kato, Shizuo, Ent., Inst. Hokkaido Imperial Univ., Sapporo, Japan. *Diptera.*
'29. Keck, Chester B., Box 340, Honolulu, Hawaii.
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'24. Kelsheimer, E. G., Corn Borer Lab., Oak Harbor, Ohio. *Behavior.*
'14. KENNEDY, C. H., Ohio St. Univ., Columbus, Ohio. (F. '27). *Odonata.*
'31. Kern, Thomas B., 740 N. Main St., Bethehem, Pa.

Ch. Kincaid, Trevor, Univ. of Wash., Seattle, Wash. *Psychodidae, Tentredionidea.*
'27. King, George E., Chazy Orchards Inc., Chazy, N. Y. *Hymenoptera.*
'14. King, H. H., Wellcome Trop. Res. Lab., Khartum, Sudan, Afr. *Diptera.*
'12. King, J. L., Box H, Moorestown, New Jersey. *Diptera.*
'23. King, Kenneth M., Univ. Sask., Saskatoon, Sask., Canada. *Noctuidae, Cicadellidae.*
'28. King, Willard V., Box 491, Orlando, Fla.
'18. KINSEY, ALFRED C., Indiana Univ., Bloomington, Ind. (F. '28). *Cynipidae.*
'28. Kislanko, J. P., Box 88, Wiggins, Miss. *Aphididae.*
'11. KNIGHT, H. H., Dept. Zool., St. Univ., Ames, Ia. (F. '28). *Hemiptera, Miridae.*
'30. Knipling, Edward, Box 48, Galesburg, Ill.
'24. Knowlton, George F., Agr., Exp. Sta. Logan, Utah. *Aphididae.*
'25. Kofoid, Chas. A., Univ. of Calif., Berkeley, Calif. *Termitidae.*
'17. Kraatz, Walter C., Univ. of Akron, Akron, Ohio.
'32. Kutchka, G. M., Dept. Ent., Univ. Ill., Urbana, Ill.
'23. Kuwayama, Satoru, Hokkaido Agr. Exp. Sta., Kotoni, Sapporo, Japan. *Neuroptera, Trichoptera, Psyllidae.*

'14. Laake, E. W., Box 208, Dallas, Texas. *Larval Muscidae, Oestridae.*
'20. LaCroix, Donald S., 24 N. Prospect St., Amherst, Mass.
Ch. Lagai, George, 8533 110th St., Richmond Hill, L. Is., N. Y. *Lepidoptera.*
'28. Lamiman, J. F., 111 Agr. Hall, Univ. Calif., Berkeley, Calif. *Acarina.*
'12. Lamkey, E. M. R., 505 S. Fell Ave., Normal, Ill.
'28. Lancaster, Horace, Parma, Idaho. *Thysanoptera, Elateridae.*
'30. Landis, B. J., 151 West Eleventh Ave., Columbus, Ohio.
Ch. Lang, Joseph N., 1433 S. 59th Ave., Cicero, Ill.
'25. Langford, George S., Dept. Ent., Univ. Maryland, College Park, Md.
'17. Langston, James M., A. & M. College, Miss. *Phyllophaga.*
'14. Larrimer, W. H., Bur. Ent., Washington, D. C. *Cicadellidae.*
'25. Larson, Andrew O., 337 N. 11th St., Corvallis, Oregon.
'13. Lathrop, F. H., 1237 Fairground Ave., Vincennes, Indiana. *Cicadellidae.*
'20. Lathy, Percy I., 90 Bd. Malesherbes, Paris, France. *Lepidoptera.*
'23. Lauderdale, J. L. E., Box 368, Yuma, Arizona.
Ch. Laurent, Philip, 31 East Mt. Airy Ave., Phila., Pa.
'17. LAWSON, PAUL B., 2244 New Hampshire, Lawrence, Kans. (F. '31). *Cicadellidae.*
'22. Learned, Elmer T., 46 Franklin St., Fall River, Mass. *Lepidoptera.*
'12. Leiby, R. W., St. Dept. Agr., Raleigh, North Carolina. *Polyembryony.*
'28. Leonard, Mortimer D., Insular Exp. Sta., Rio Piedras, Porto Rico. *Leptidae.*
'31. Lewis, Ralph H., Todd Union, Univ. of Rochester, Rochester, N. Y.
'26. Light, S. F., University of Calif., Berkeley, Calif. *Isoptera.*
'17. Lindsey, A. W., Box 782, Granville, Ohio. *Hesperioidea.*
'32. Ling, Shao-wen, Dept. Ent., Cornell Univ., Ithaca, N. Y.
'25. List, Geo. M., Agricultural College, Fort Collins, Colo. *Cimicidae.*
'24. Liu, Chung Lo, Dept. Biol., Tsing Hua College, Peking, China. *Vespidae, Bombidae.*
'30. Livingstone, E. M., 200 Bland Street, Richmond, Virginia. *Thysanoptera, Orthoptera.*
Ch. Lloyd, J. T., 6624 Kennedy Ave., Cincinnati, Ohio. *Trichoptera.*
'31. Lloyd, Llewellyn, University, Leeds, England.
'19. Lobdell, Mrs. Gladys H., Belleglade, Fla. *Coccidae, Aleurodidae.*
'30. Loftin, U. C., Bur. Ent., Washington, D. C.
'25. Long, W. W., Eighty-Four, Pa. *Lepidoptera.*
'30. Lopez, A. W., Box 1493, Manila, Philippine Is. *Scoludae, Scarabaeidae.*
'31. Loring, Chas. A., Cole Ave., Highland, Calif.
'29. Lott, Earl, Box H, Moorestown, New Jersey.
'13. Luginbill, Philip, Drawer 359, Monroe, Mich. *Phillophaga.*
'18. Lundbeck, William, Zool. Mus. of Copenhagen, Copenhagen, Denmark. *Diptera.*
Ch. LUTZ, FRANK E., Am. Mus. Nat. Hist., 77th St. & Cen. Park West, New York, N. Y. (F. '17). *Bees.*

'31. Lyle, Clay, A. & M. College, Miss.

'28. MacAloney, H. J., Northwestern Forest Exp. Sta., Amherst, Mass. *Timber Insects.*
'28. MacAndrews, A. H., College of Forestry, Syracuse, N. Y. *Timber Insects.*
'14. McAtee, W. L., Biol. Surv., Dept. Agr., Washington, D. C. *Hemiptera.*
'20. McBride, O. C., Box 340, Honolulu, Hawaii. *Toxicity.*
'29. McClanahan, Annie Laurie, Box 184, A. & M. College, Miss.
'29. McClure, H. Elliott, 1104 W. Stoughton, Urbana, Ill.
'17. McCracken, Isabel, Box 1545, Stanford University, Calif. *Cynipidae, Apoidea.*
'10. McDaniel, Eugenia, Agr. College, Amherst, Mass. *Coccidae, Orthoptera.*
'12. McDUNNOUGH, J., Ent. Branch, Dept. Agr., Ottawa, Canada. (F. '20). *Lepidoptera, Ephemerida.*
'30. McGough, J. M., Box 284, Morton, Miss.
'30. McGovran, E. R., St. Entomologist Bldg., Urbana, Ill.
'25. McGregor, E. A., Box 576, Lindsay, Calif. *Mallophaga, Tetranychidae.*
'29. McIllroy, Wm. D., Jr., 192 Prospect Ave., Ingram, Pittsburgh, Pa. *Hymenoptera, Ichneumonidae.*
'11. McIndoo, N. E., 7225 Blair Rd., Takoma Park, Washington, D. C. *Insect Physiology.*
'30. McNally, A. G., 390 Colborne Street, London, Ontario, Canada.
'17. Maheux, Georges, Dept. Agr., Parliament Bldg., Quebec, Canada. *Timber Insects.*
'31. Mail, G. Allen, Dept. Ent., Mont. St. College, Bozeman, Mont.
'28. Maloney, George A., Tallulah, La.
'21. *Mank, Edith Webster, 12 Reservoir St., Lawrence, Mass. *Coleoptera.*
'21. Mank, Helen G., 12 Reservoir St., Lawrence, Mass.
'13. *Mann, Wm. M., Nat. Zool. Park, Washington, D. C. *Formicidae.*
'23. Manter, Jerauld A., Agr. College, Storrs, Conn.
'22. Marcovitch, S., Univ. Farm, Knoxville, Tenn.
Ch. MARLATT, C. L., 1521 16th St., N. W., Washington, D. C. (F. '08). *Coccidae.*
Ch. MARSHALL, W. S., 139 E. Gilman St., Madison, Wis. (F. '17). *Morphology.*
'30. Marston, Chester, Jr., Dept. Biol., Univ. of Toronto, Toronto 5, Ont., Canada.
'25. Martin, Chas. H., Bur. Ent., Sumner, Wash. *Diptera.*
'31. Martin, Paul, Casilla 112, Lima, Peru, S. A.
'28. Marvin, George E., 423 Dorset Ave., Chevy Chase, Washington, D. C.
'21. Mason, Arthur C., Box 340, Honolulu, Hawaii. *Thysanoptera.*
'30. Mason, Horatio C., 151 West 11th Ave., Columbus, Ohio.
Ch. MATHESON, ROBT., Cornell Univ., Ithaca, N. Y. (F. '28). *Ixodoidea, Culicidae.*
'28. Mayer, Chas. C., Dept. Ent., Ohio St. Univ., Columbus, Ohio. *Hemiptera, Coleoptera.*
'27. Maynard, Elliott A., Dept. Biol., Univ. of Rochester, Rochester, N. Y. *Collembola.*
'25. Meiners, Edwin, 6600 Delmar Blvd., St. Louis, Mo. *Lepidoptera.*
Ch. MELANDER, A. L., City College of N. Y., Convent Ave. at 139th St., New York, N. Y. (F. '14). *Diptera.*
'27. Melvin, Roy, Box 208, Dallas, Texas. *Physiology.*
'31. Menzies, T. P. O., Curator City Museum, Vancouver, Brit. Col., Canada.
'23. Merrill, G. B., St. Plant Bd., Gainesville, Fla. *Coccidae, Aleyrodidae.*
'12. METCALF, C. L., Nat. Hist. Bldg., Univ. of Ill., Urbana, Ill. (F. '20). *Syrphidae.*
'09. Metcalf, Z. P., State College Station, Raleigh, N. Carolina. *Homoptera.*
'17. Mickel, Clarence E., Div. Ent., Univ. Farm., St. Paul, Minn. *Multillidae.*
'31. Miller, Albert C., 381 W. Ninth Ave., Columbus, Ohio.
'28. Miller, D. F., St. Univ., Dept. Zool., Columbus, Ohio. *Insect Physiology.*
Ch. Miller, Mrs. Ellen R., 220 Fla. Ave., Coronado Beach, Fla. *Lepidoptera.*
'30. Miller, Forrest W., Dept. Zool., Univ. of Pittsburgh, Pittsburgh, Pa. *Aphididae.*
'28. Miller, Ralph L., Box 491, U. S. D. A., Orlando, Fla.

'25. Miller Warren C., 111 Ellenwood Ave., Bedford, Ohio. *Coleoptera, Hymenoptera.*
'29. Mills, Harlow B., Sci. Bldg., Ames, Iowa. *Collembola.*
'25. Mills, Wier R., Pierston, Iowa. *Lepidoptera.*
'25. Milum, Vern G., 110 Vivavium Bldg., Champaign, Ill. *Apiculture.*
'26. Minnich, D. E., Dept. Zool., Univ. of Minn., Minneapolis, Minn. *Behavior.*
'21. Mitchell, T. B., Dept. Zool., St. College, Raleigh, N. Carolina. *Apoidea, Megachile.*
'30. Miwa, Yushiro, Dept. Agr., Gov. Research Inst., Taihoku, Formosa. *Elateridae.*
'21. *Moffatt, Elizabeth M., 273 S. Witmer St., Los Angeles, Calif. *Araneida.*
'28. Mohr, Carl O., Nat. Hist. Surv., Urbana, Ill. *Coleoptera.*
'22. MONTGOMERY, B. ELWOOD, Dept. Ent., Purdue Univ., Lafayette, Ind. (F. '31). *Odonata.*
'29. Moody, D. L., Dept. Ent., Univ. of Maine, Orono, Maine. *Hemiptera, Coleoptera.*
'08. Moore, Wm., American Cyanamid Co., Azusa, Calif. *Insecticides.*
'28. Moreland, R. W., Bryan, Texas.
'32. Merino, Gonzalo, Dept. Ento., Ohio St. Univ., Columbus, Ohio.
'08. Morgan, Ann H., Mt. Holyoke College, South Hadley, Mass. *Ephemeridae.*
Ch. Morgan, H. A., Univ. of Tenn., Knoxville, Tenn.
'27. Morgan, W. P., 4115 Otterbein Ave., Indianapolis, Ind. *Dermaptera.*
'28. Morofsky, W. F., Box 771, East Lansing, Mich. *Forest Insects.*
Ch. Morrill, A. W., 1505 Winchester Ave., Glendale, Calif.
'12. MORRISON, HAROLD, Bur. Ent., Washington, D. C. (F. '28). *Coccidae.*
Ch. MORSE, A. P., 16 Upland Road, Wellesley, Mass. (F. '14). *Orthoptera, Odonata.*
'08. MOSHER, EDNA, Adelphi College, Garden City, N. Y. (F. '20). *Lepidoptera.*
'20. Mote, Don C., St. Agr. College, Cornvallis, Oregon.
'29. MOULTON, DUDLEY, St. Office Bldg., Sacramento, Calif. (F. '31). *Thysanoptera.*
'25. Mueller, Arthur E., 12 Armin Ave., Webster Groves, Mo.
'15. Muesebeck, C. F. W., Nat. Mus., Washington, D. C. *Braconidae, Chalcidoidea.*
'30. Mundell, R. C., Box 509, Uvalde, Texas. *Parasitic Hymenoptera.*
'24. Munro, H. K., Box 513, Pretoria, South Africa. *Trypetidae, Diptera.*
'27. Munro, J. A., State College Station, Fargo, N. Dakota. *Orthoptera, Diptera.*
'28. Musgrave, Anthony, Australian Museum, College St., Sydney, N. S. W. Australia. *Nycteribiidae.*
'27. Musgrave, Paul N., 514 Mt. Vernon Ave., West Va. *Chrysomelidae.*
'17. Mutchler, A. J., Am. Mus. Nat. Hist., 77th St. and Central Park West, New York, N. Y. *Coleoptera.*
'15. Muttkowski, R. A., Univ. of Detroit, Detroit, Mich. *Odonata.*
'30. Myers, L. E., Jr., 1316 So. Central Ave., Glendale, Calif.

'30. Nash, Robley, W., Forest Service, St. House, Augusta, Maine.
Ch. NEEDHAM, J. G., 6 Needham Place, Ithaca, N. Y. (F. '07). *Odonata, Emphemerida.*
'26. Needham, P. R., 46 N. Main St., Hackettstown, N. J. *Ecology.*
'21. Neiswander, C. R., Ohio Agr. Exp. Sta., Wooster, Ohio.
'28. Neiswander, R. B., Agr. Exp. Sta., Wooster, Ohio.
'07. Nelson, J. A., Gambier, Ohio.
Ch. Ness, Henry, 821 Kellogg Ave., Ames, Iowa.
Ch. Newcomb, Wm. W., 1245 Ferdon Rd., Ann Arbor, Mich. *Lycaenidae, Noctuidae.*
Ch. Newcomer, E. J., Box 243, Yakima, Washington.
'07. Newell, Wilmon, St. Plant Bd., Gainesville, Fla.
'15. Newman, Geo. B., 125 W. Beaver Ave., State College, Pa. *Ins. Histology.*
'28. Newton, Richard C., 610 W. 10th St., Medford, Oregon. *Trichoptera.*
'27. Nichol, Andrew A., University of Arizona, Tucson, Arizona. *Coccidae, Meridae.*
'31. Nichols, C. B., Box 209, Bur. Ent., Brownwood, Texas.

'22. Noble, W. B., Box 495, U. S. Ent. Lab., West Lafayette, Ind.
'17. *Notman, Howard, Circle Rd., Dougan Hills, S. I., N. Y. *Carabidae, Staphylinidae.*

'31. O'Byrne, Harold I., 501 Pacific Ave., Webster Groves, Mo. *Lepidoptera. Hesperidae.*
'27. O'Dell, J. H., Box 1857, Phoenix, Arizona.
'08. O'KANE, WALTER C., Durham, N. Hampshire. (F. '24).
'16. Olsen, Chris. E., Am. Mus. Nat. Hist., West 77th St., New York, N. Y. *Hemiptera.*
'29. Oman, Paul W., Div. Insects, Nat. Mus., Washington, D. C. *Homoptera.*
Ch. OSBORN, HERBERT, St. Univ., Columbus, Ohio. (F. '07; H. F. '28). *Homoptera, Cicadellidae.*
'08. Osborn, H. T., 1952 Concord Rd., Columbus, Ohio.
Ch. OSBORN, R. C., St. Univ., Columbus, Ohio. (F. '17). *Syrphidae.*
'20. Otanes, Faustino Q., Bur. of Plant Industry, Manila, Philippine Is. *Coccidae.*
'25. Ozburn, Reg. H., Ont. Agr. College, Guelph, Ont., Canada.

'15. Packard, Clyde M., Box 495, West Lafayette, Ind. *Orthoptera.*
'18. Painter, H. R., Box 495, West Lafayette, Ind. *Acrididae.*
'19. Painter, R. H., Ent. Dept., Kans. St. College, Manhattan, Kans. *Diptera, Bombyliidae.*
'23. Pallister, John C., 2717 Euclid Ave., Cleveland Mus. Nat. Hist., Cleveland, Ohio. *Coleoptera.*
'27. Palmer, Miriam, Dept. Ent., Agr. College, Fort Collins, Colo. *Aphidae.*
'28. Park, Andrew R., Jr., St. Nat. Survey, Urbana, Ill. *Ichneumonidae.*
'27. Park, Orlando, 905 South First St., Champaign, Ill. *Cryptophagidae.*
'24. Parker, Donald L., 17 East Highland Ave., Melrose Highlands, Mass.
'25. Parker, H. L., European Parasite Lab., Avenue Godilott, Hyers (Var)., France. *Behavior.*
'18. Parker, J. B., 1217 Lawrence St., N. E., Washington, D. C. *Bembicidae.*
'24. Parker, R. L., Dept. Ent., Kan. St. College, Manhattan, Kan. *Apiculture.*
'16. Parker, R. R., Box 837, Hamilton, Mont. *Sarcophagidae, Acarina.*
'16. Parks, H. B., Route 1, Box 368, San Antonio, Texas. *Apiculture.*
'18. Parks, T. H., Dept. Ent., St. Univ., Columbus, Ohio.
'24. Parman, D. C., Box 509, Uvalde, Texas. *Diptera, Siphonoptera.*
Ch. PARROTT, P. J., Agr. Exp. Sta., Geneva, N. Y. (F. '14).
'12. Parshley. H. M., Dept. Zool., Smith College, Northampton, Mass. *Heteroptera.*
Ch. *PATCH, EDITH M., Agr. Exp. Sta., Orono, Maine. (F. '14). *Aphidae.*
'25. Patch, L. H., Box 976, Sandusky, Ohio.
'26. Pate, V. S. L., Ent. Dept., Cornell Univ., Ithaca, N. Y. *Sphecoidea, Hymenoptera.*
Ch. Paxson, Owen S., Radnor, Delaware Co., Pa.
'23. Payne, Nellie M., 431 Pottawatomie Ave., Manhattan, Kans. *Trichoptera.*
'20. Peairs, L. M., Morgantown, West Va.
'30. Pepper, B. B., Dept. Ent., Agr. Exp. Sta., New Brunswick, N. J.
'28. Pepper, J. O., 603 East King St., Chambersburg, Pa. *Pentatomidae, Cicadellidae, Membracidae, Cercopidae.*
'29. Peters, Harold T., 1545 Mass. St., Lawrence, Kansas. *Xextocephalus.*
'11. PETERSON, ALVAH, Dept. Ent., St. Univ., Columbus, Ohio. (F. '28). *Diptera.*
'07. Petrunkevitch, Alexander, Yale Univ., New Haven, Conn. *Arachnida.*
Ch. Pettit, R. H., Agr. Exp. Sta., East Lansing, Mich. *Coccidae.*
'28. Phillips, Arthur M., Baldwyn, Miss. *Diptera, Coleoptera.*
'21. PHILLIPS, E. F., Cornell Univ., Ithaca, N. Y. (F. '29). *Apiculture.*
'29. Phillips, Griffin L., Baldwyn, Miss.
'12. Phillips, W. J., Box 592 Charlottesville, Va. *Harmolita.*
'25. Phipps, C. R., Agr. Exp. Sta., Orono, Maine. *Noctuidae.*
'29. Piatt, Jean, 344 Northern Ave., Indianapolis, Ind. *Odonata, Coleoptera.*
Ch. PIERCE, W. DWIGHT, 234 Oxford Rd., Brookline, Upper Darby, Pa. (F. '30). *Rhynchoptera.*
'28. Plank, H. K., St. Dept. Agr., Sacramento, Calif. *Parasitic Diptera and Hymenoptera.*

'24. Plath, O. E., Boston Univ., Boston, Mass. *Bremidae.*
'28. Plummer, C. C., Rancho Amanalco, Cuernavaca, Morelos, Mexico. *Epilachnina, Membracidae.*
'25. Polivka, J. B., Oak Harbor, Ohio.
'18. Poos, Fred W., Arlington Farm, Rosslyn, Va.
'18. Pope, Thomas E. B., Public Museum, Milwaukee, Wis.
'23. Porter, B. A., Bur. Ent., Washington, D. C.
'26. Potts, Samuel F., 1156 Main St., Melrose Highlands, Mass. *Taxicology, Physiology.*
'25. Powell, Eugene F., 125 Bessey Hall, Univ. of Nebr., Lincoln, Nebr. *Chrysomelinae.*
Ch. Powell, P. B., Clinton, New York.
'23. Powers, Edwin B., Dept. Zool., Univ. of Tenn., Knoxville, Tenn.
'31. Preston, Roger L., 303 S. Madison St., Bloomfield, Iowa.
'16. Price, W. A., Univ. of Ky., Lexington, Ky. *Aphidae.*
'32. Pritchard, Arthur E., 410 East 16th, Oklahoma City, Okla.
'28. Procter, Wm., Bar Harbor, Maine.
'28. Proper, A. B., 1156 Main St., Melrose Highlands, Mass.
'16. Psota, F. J., 2434 S. Crawford Ave., Chicago, Ill.

Ch. QUAINTANCE, A. L., Silver Springs, Md. (F. '14).

Ch. Ramsden, Chas. T., Box 146, Quantanamo, Cuba. *Lepidoptera.*
'14. RAU, PHIL, 549 E. Argonne Drive, Kirkwood, Mo. (F. '27). *Hymenoptera, Behavior.*
'23. Readio, Philip A., Dept. Ent., Univ. Kansas, Lawrence, Kans. *Reduviidae.*
'29. Reed, L. B., Box 146, Chadbourn, North Carolina. *Lepidoptera.*
'23. Reed, Wm. D., 200 Bland St., Richmond, Va.
'19. Reeher, Max M., Forest Grove, Oregon.
'30. Rees, Don M., Univ. of Utah, Salt Lake City, Utah. *Culicidae.*
'23. Reeves, Jos. A., Fern Park, Fla. *Chrysomelidae, Fulgoridae.*
'08. Regan, W. S., 214 West 14th St., New York, N. Y.
Ch. REHN, J. A. G., Acad. Nat. Sciences, Logan Square, Philadelphia, Pa. (F. '14). *Dermaptera, Orthoptera.*
'30. Richards, A. Glenn, Jr., Ent. Dept., Cornell Univ., Ithaca, N. Y. *Noctuidae.*
'14. RICHARDSON, CHAS. H., Dept. Ent., Ia. St. Univ., Ames, Ia. (F. '31). *Physiology.*
'29. Richardson, H. H., Bur. Ent., Washington, D. C. *Physiology.*
'28. Richmond, Edward A., 39 Newbury St., Brockton, Mass. *Hydrophilidae.*
'22. Ries, Donald T., Cranbrook Inst. of Sci., Bloomfield Hills, Mich. *Noctuidae, Siricidae, Trypetidae.*
Ch. Riley, C. F. Curtis, Univ. of Manitoba, Winnipeg, Canada. *Gerridae.*
'27. Riley, Harland K., Dept. Agr., Southwestern La. Inst., Lafayette, La. *Diptera.*
'29. Riley, Merrill K., Dept. Zool., Ia. St. College, Ames, Ia. *Coccidae.*
Ch. RILEY, WM. A., Dept. Animal Biol., Univ. Minn., Minneapolis, Minn. (F. '14). *Parasitology.*
'28. Rippey, Herald K., St. Ent. Office, St. House, Indianapolis, Ind. *Forest Insects.*
'25. Rivnay, Ezekiel, P. Z. E. Agr. Exp. Station, Tel-Aviv, Palestine. *Phipiphoridae.*
'31. Roberts, J. Harvey, Box 376, Univ. Station, Baton Rouge, La. *Trichoptera.*
'28. Roberts, Raiford A., Box 509, Uvalde, Texas. *Hymenoptera.*
'15. Robinson, J. M., Auburn, Alabama. *Coccidae, Coleoptera.*
'26. Robinson, Wm., 2401 Calvert St., N. W., Washington, D. C. *Physiology.*
'13. Rockwood, L. P., Forest Grove, Oregon. *Noctuidae, Orthoptera.*
'31. Rodeck, Hugo G., Div. Ent., Univ. Farm, St. Paul, Minn. *Nomada.*
'15. Rogers, J. Speed, Box 2666 Univ. Sta., Gainesville, Fla. *Tipulidae.*
'23. Rogers, Leslie, Lakota Lodge, Knoxville, Tenn. *Lepidoptera, Orthoptera.*
'27. ROHWER, S. A., Bur. Ent., Washington, D. C. (F. '29). *Hymenoptera.*
'28. Roney, J. N., Plant Lice Lab., Dickinson, Texas. *Coccidae.*
'22. Root, F. M., Sch. Hyg. & Pub. Health, 615 N. Wolfe St., Baltimore, Md. *Culicidae.*

'14. Rosenfeld, A. H., 1005 N. O. Bank Bldg.. New Orleans, La.
'25. Rosewall, O. W., Dept. Ent., St. Univ., Baton Rouge, La. *Coleoptera, Pentatomidae.*
'31. Ross, Herbert H., St. Nat. Hist. Surv., Urbana, Ill.
'12. Ross, Wm. A., Vineland Station, Ontario, Canada. *Aphididae.*
'31. Roudabush, Robert L., Ia. St. College, Ames, Iowa.
'14. Ruckes, Herbert, 167-11 33rd St., Flushing, L. I., New York. *Hemiptera.*
Ch. Ruggles, A. G., Univ. Farm, St. Paul, Minn.
Ch. Rumsey, W. E., 443 Park St., Morgantown, West Va.

'29. Sakimura, Kay, Exp. Sta. A. H. P. C., Univ. of Hawaii, Honolulu, Hawaii. *Thysanoptera.*
'23. Salman, K. A., 341 Giannini Hall, Univ. Calif., Berkeley, Calif. *Psammocharidae.*
'28. Salt, George, Zoological Lab., Cambridge, England. *Strepsiptera.*
Ch. SANDERS, J. G., c/o Sun Oil Co., 1608 Walnut St., Phila., Pa. (F. '20).
'28. Sanders, Paul D., Bur. Ent., Washington, D. C.
'31. Sanderson, Milton W., 1919 Vermont St., Lawrence, Kans. *Parnidae.*
'31. Sargent, Wm., D. Forest Home, Ithaca, N. Y.
'07. SATTERTHWAIT, A. F., 527 Ivanhoe Place, Webster Groves, Mo. (F. '30). *Calendra.*
'24. Sazama, Robert F., 909 State St., Vincennes, Ind.
'29. Scaramuzza, L. C., c/o J. Pennino, Avenue Menocal 45, Havana, Cuba.
'31. Schaefer, E. J. 4471 North Farwell Ave., Milwaukee, Wis.
'30. Schaefer, Paul E., Dept. Ent., Ohio St. Univ., Columbus, Ohio. *Coleoptera.*
'25. Schear, E. W. E., 107 W. Park St., Westerville, Ohio. *Hemiptera, Diptera, Hymenoptera.*
'30. Schlosberg, Morris, 615 Front St., Toledo, Ohio. *Lepidoptera.*
'29. Schmidt, Carl T., Box 3166, Honolulu, Hawaii.
'20. Schmieder, Rudolf G., Zool. Lab., Univ. of Penna., Phila., Penna.
Ch. Schoene, W. J., Agr. Exp. Sta., Blacksburg, Va.
'29. Schroeder, Herman, Agri. Exp. Sta., Brownsville, Texas. *Ixodoidea.*
'26. Schwardt, H. H., Dept. Ent., Ark. Univ., Fayetteville, Ark. *Tabanidae.*
'28. Schwarz, Ernest, St. Game & Fish Dept., Jefferson City, Mo. *Catocala.*
'25. Schwarz, Eugene W. K., 9929 Shore Rd., Brooklyn, N. Y.
'26. Schwarz, Herbert F., Am. Mus. Nat. Hist., 77th St. & Central Park West, New York, N. Y. *Apoidea.*
'28. Scotland, Minnie B., 42 Continental Ave., Cohoes, N. Y. *Hydroporus.*
'25. Scullen, H. A., 325 So. 13th St., Corvallis, Oregon. *Hymenoptera.*
'23. Seamans, H. L., Dom. Ent. Lab., Lethbridge, Alberta, Canada. *Muscoidea.*
'22. Sellers, W. F., 35/a Martonhegyi ut., Budapest I, Hungary. *Tachinidae.*
'29. Setty, Laurel R., Park College, Parkville, Mo. *Mecoptera, Bittacus.*
'08. Severin, H. C., Brookings, S. Dakato. *Orthoptera, Homoptera, Heteroptera.*
'07. Shafer, Geo. D., 321 Melville Ave., Palo Alto, Calif.
'18. *Shannon, R. C., U. S. Nat. Mus., Washington, D. C. *Diptera.*
'32. Sharga, U. S., Dept. Agr., Etawah, U. P. India. *Thysanoptera.*
'29. Shaw, J. Gilbert, 808 Alabama, St., Lawrence, Kansas.
'26. Shaw, S. Albert, Hampton, New Hampshire. *Diptera, Coleoptera.*
'28. Sheaffer, Frank E., 636 W. 38th St., Indianapolis, Ind.
'28. Sheffield, S. S., St. Plant Bd., Orlando, Fla.
Ch. SHELFORD, V. E., Vivarium Bldg., Wright and Healy St., Champaign, Ill. (F. '20). *Ecology.*
'22. Shepard, Harold H., University Farm, St. Paul, Minn. *Hesperiidae.*
'17. Sherman, Franklin, Div. Ent., Clemson College, So. Carolina. *Acrididae, Cerambycidae, Cicindellidae.*
'11. Sherman, John D., Jr., 132 Primrose Ave., Mount Vernon, N. Y. *Dytiscidae.*
'23. Shotwell, Robert L., Ent. Lab., State College, Bozeman, Mont.
'28. Shropshire, Leslie H., Box 352, Arlington Heights, Ill.
Ch. Shull, A. Franklin, 431 Highland Rd., Ann Arbor, Mich. *Aphididae.*
'29. Shull, W. E., 812 Carroll Ave., Ames, Iowa. *Hemiptera, Coleoptera.*
'20. Sibley, C. K., R. F. D. 2, Box 1021, Clayton, Mo. *Trichoptera.*

'31. Siddall, Cameron, Div. Ent., Agr. Exp. Sta., College Station, Texas. *Meloidae.*
'28. Siegler, E. H., Bur. Ent., Washington, D. C.
'15. SILVESTRI, FILIPPO, Scuola Superiore d'Agricoltura, Portici, Italy. (F. '20). *Thysanura, Protura, Termites, Myriapoda.*
'29. Simmons, Perez, 712 Elizabeth St., Fresno, Calif. *Nitidulidae.*
'30. Simmons, S. W., Bur. Ent., Washington, D. C.
'25. Simons, Mrs. Carrie L., 4021 Alameda Drive, San Diego, Calif.
'30. Simpson, Geddes W., Holmes Hall, Orono, Me.
'28. Sleesman, J. P., Agr. Exp. Sta., Wooster, Ohio. *Homoptera, Cicadellidae.*
'28. Smith, Clifton H., Hopper, Utah. *Thysanoptera.*
'27. Smith, Chester W., 228 Dundas St., E. Belleville, Ontario, Canada. *Tachinidae.*
'27. Smith, Floyd F., Bur. Ent., Washington, D. C. *Aphididae.*
'28. Smith, Herbert D., European Parasite Lab., Le Mont Fenouillet, Hyeres, Var. France. *Ichneumonidae.*
Ch. Smith, James A., 414 E. Broad St., Westfield, N. J.
'19. Smith, Marion R., St. Plant Bd., A. & M. College, Miss. *Formicidae.*
'14. SMITH, ROGER C., Dept. Ent., Kan. St. College, Manhattan, Kansas. (F. '31). *Neuroptera.*
'14. Smulyan, M. T., Bur. Ent., Melrose Highlands, Mass. *Tenthredinidae.*
Ch. Smyth, Ellison A., Jr., Route 2, Box 166, Salem, Va. *Papilionidae, Sphingidae.*
'30. Smyth, E. G., Hacienda Cartavio, Salaverry, Peru, S. A.
'18. Snapp, Oliver I., Box 445, Fort Valley, Georgia. *Rhynchophora.*
'24. SNODGRASS, R. E., 3706 13th St., N. W., Washington, D. C. (F. '27). *Morphology.*
'29. Solberg, Archie N., 1307—13th St. North, Fargo, N. Dakota. *Ins. Physiology.*
'26. Sorenson, Chas. J., Agr. Exp. Sta., Logan, Utah.
'30. Speicker, Benj. R., Dept. Zool., Univ. Pittsburgh, Pittsburgh, Pa.
'14. *Spencer, G. J., Univ. of Brit. Col., Vancouver, Brit. Col., Canada. *Trypetidae.*
'19. Spencer, Herbert, Box 482, Albany, Ga. *Hymenoptera.*
'31. Spieth, Herman T., College of City of N. Y., Convent Ave. & 139th St., New York, N. Y. *Ephemeridae.*
Ch. Spooner, Chas. S., 1436 7th St., Charleston, Ill. *Hemiptera.*
'29. Spruijt, F. J., Box 786, Babylon, L. I., N. Y. *Hymenoptera parasites.*
'22. Spuler, Anthony, Wenatchee, Washington. *Diptera, Borboridae.*
'25. Squire, E. H. P., 175 Main St., White Plains, New York. *Coleoptera.*
'29. Stabe, Henry A., St. Univ., Baton Rouge, La. *Apiculture.*
'10. Stafford, E. W., A. & M. College, Miss. *Acalyterate Muscoids.*
'19. Stahl, C. F., Box 549, Sanford, Fla.
'30. Stanford, J. S., Agr. College, Logan, Utah. *Siphonaptera.*
'30. Stanley, W. W., Agr. Exp. Sta., Knoxville, Tenn. *Phalaenidae.*
'19. Stear, J. R., 119 Deeds St., Ligonier, Pa. *Miridae.*
'17. Stearns, Louis A., Agr. Exp. Sta., Newark, Dela. *Cercopidae, Cicadellidae.*
'23. Steele, Brandt F., 910½ West Drive, Woodruff Place, Indianapolis, Ind. *Coleoptera.*
'27. Steiner, L. F., Cornelia, Georgia.
'29. Steinweden, John B., St. Agr. Bldg., Mission & Embarcadera Sts., San Francisco, Cal. *Coccidae, Thysanoptera.*
'28. Stene, A. E., Rhode Is. State Board of Agr., Kingston, Rhode Island.
'25. Stephenson, Lyle, 35 West 52nd St., Kansas City, Mo.
'21. Stevens, O. A., College Station Fargo, N. Dakota. *Bees, Wasps.*
'28. Stevenson, W. A., Box 1896, Tucson, Ariz.
'31. Stewart, M. A., The Rice Inst., Houston, Texas. *Siphonaptera.*
'17. Stickney, Fenner S., 521 N. Pickering Ave., Whittier, Calif. *Coccidae.*
'15. Stiles, Chas. F., Box 37, Stillwater, Okla.
'29. Stirland, L. LaGrande, Plant. Pathology Dept., Cornell Univ., Ithaca, N. Y.
'31. Stoffers, F. K., 462 No. 2 E., Logan, Utah.
'27. Stone, Alan, Bur. Ent., Dept. Agr., Washington, D. C. *Diptera, Tabanidae.*
'28. Stone, Marshall W., Box 297, Alhambra, Calif. *Elateridae.*
'28. Stone, Wm. E., Laboratorio Entomologico, Calzada Tacuba 153, Col. Anahuac, Mexico, D. F.

'13. Stoner, Dayton, 603 So. Summitt St., Iowa City, Iowa. *Pentatomoidea.*
'30. Strand, A. L., State College, Bozeman, Mont. *Physiology.*
'27. Street, Thomas M., School of Forestry, Bottineau, North Dakota.
'12. Strickland, E. H., Univ. of Alberta, Edmonton, Alberta, Canada.
'27. Sullivan, K. C., St. Bd. Agr., Jefferson City, Mo. *Chironomidae, Culicidae.*
'31. Summerour, A. R., Box 90, Lucdale, Miss.
'08. Summers, John N., 20 Abbott St., Greenfield, Mass. *Coccidae.*
'31. Sumner, Francis H., 760 Univ. Ave., Palo Alto, Calif. *Chalcidoidea.*
'20. SWAINE, JAMES M., Dept. Agriculture, Ottawa, Canada. (F. '21). *Forest Insects.*
'23. Sweetman, Harvey L., State College, Amherst, Mass. *Ecology.*
'20. SWEZEY, OTTO H., 2048 Lanihuli Drive, Honolulu, Hawaii. (F. '30). *Lepidoptera.*
'22. Swingle, H. S., Exp. Sta., Auburn, Ala. *Physiology.*
'28. Swinyard, Chester A., 467 Blvd., Logan, Utah. *Homoptera.*
'29. Swope, Edwin, 730 Kentucky St., Lawrence, Kansas.

'27. Tanner, Vasco M., Brigham Young Univ., Provo, Utah. *Tenebrionidae, Carabidae.*
Ch. Tanquary, M. C., Univ. Farm, St. Paul, Minn. *Formicidae, Apiculture.*
'31. Tate, H. D., Dept. Zool., Ia. St. College, Ames, Ia.
'22. Taylor, Leland H., Dept. Zool., W. Va. Univ., Morgantown, W. Va. *Chrysididae.*
'29. Taylor, R. L., Dept. Biol., College of William & Mary, Williamsburg, Va. *Parasitic Hymenoptera.*
'21. Thomas, Chas. A., Kennett Square, Chester County, Pa. *Elateridae.*
'32. Thomas, E. S., Ohio State Museum, O. S. U., Columbus, Ohio.
'15. Thomas, F. L., College Station, Texas.
'09. Thomas, Wm. A., Chadbourn, North Carolina.
'31. Thomas, Wylie L., Dept. Ent., Utah St. Agr. College, Logan, Utah.
'31. Thompson, Friar M., Jr., Agr. Exp. Sta., New Brunswick, N. J.
'29. Thomson, James R., Box 445, Fort Valley, Ga.
'31. Thurber, George A., Dept. Ent., St. College, Ames, Iowa. *Rhyncophora, Trypetidae.*
'22. Tietz, H. M., Dept. Zool., Pa. St. College, State College, Pa. *Noctuidae.*
'20. TILLYARD, R. J., Chief Comm. Entomologist, Canberra, F. C. T., Australia. (F. '28). *Fossil Ins., Odonata.*
'11. Timberlake, P. H., Citrus Exp. Sta., Riverside, Calif. *Encyrtidae.*
'28. Tinkham, Ernest R., Box 111, Presidio, Texas. *Rhopalocera, Orthoptera, Odonata.*
'23. Tissot, A. N., Agr. Exp. Sta., Gainesville, Fla. *Aphididae.*
Ch. Titus, E. G., 1080 Fifth East, Salt Lake City, Utah. *Apoidea.*
'26. Todd, F. E., St. Dept. of Agr., Sacramento, Calif. *Bees.*
'29. Tosawa, Nybuyoshi, Kotoen, Mukogun, Hiogo Perfecture, Japan. *Hymenoptera.*
'28. Townsend, Lee H., Dept. Ent., Univ. of Ill., Urbana, Ill.
'21. Townsend, M. T., Dept. Biol., Wesleyan Univ., Bloomington, Ill.
'30. Traver, Jay R., 516 Stewart Ave., Ithaca, N. Y. *Ephemeridae.*
'30. Travis, Bernard V., Dept. Zool., Ia. St. College, Ames, Ia. *Phyllophaga, Cicindelidae.*
'29. Tsou, Y. H., Kiangsu Farmers Bank, Chinkiang, China.
'28. Tulloch, Geo. S., Mus. Comp. Zool. Oxford St., Cambridge, Mass.
'08. Turner, Wm. F., 208 Anderson Ave., Ft. Valley, Ga.
'29. Tuthill, L. D., 246 E. 13th St., Baxter Springs, Kansas. *Cicadellidae, Fulgoridae.*

'20. Uichanco, L. B., Agr. College, Laguna, P. Islands. *Psyllidae, Aphididae.*
'17. Urich, F. W., 107 Frederick St., Port of Spain, Trinidad, Brit. West Indies. *Tropical Economic Ent.*

'25. Valentine, J. Manson, Box 30, Chapel Hill, North Carolina. *Carabidae, Cicindelidae.*

'22. Vance, Arlo M., Dept. Agr., 10 Court St., Arlington, Mass.
'29. Vanderford, H. T., St. Plant Bd., Maben, Miss. *Ants.*
Ch. Van Dine, D. L., Central Baragua, Provincia de Camaguey, Cuba.
Ch. VAN DUZEE, E. P., Calif, Acad. of Sci., G. G. Park, San Francisco, Calif. (F. '12). *Hemiptera.*
'17. VAN DUZEE, M. C., 12 Abbotsford Place, Buffalo, N. Y. (F. '30). *Dolichopodidae, Diptera.*
Ch. VAN DYKE, E. C., Agr. Hall, Univ. of Calif., Berkeley, Calif. (F. '17). *Coleoptera.*
Ch. Vickery, R. A., Box 884, San Antonio, Texas.
'13. Vorhies, Chas. T., Univ. Ariz., Tucson, Ariz.
'27. Voris, Ralph, St. Teachers College, Springfield, Mo. *Staphylinidae.*

'15. Wade, J. S., Bur. Ent., Washington, D. C. *Coleoptera.*
'21. Wadley, F. M., Bur. Ent., Washington, D. C. *Aphididae.*
'18. Wainwright, C. J., 172 Hamstead Rd., Handsworth, Birmingham, England. *Tachinidae.*
'22. Wakeland, Claude, Dept. Ent., Univ. Idaho, Moscow, Idaho. *Eleodiini.*
'22. Walkden, Herbert H., 128 S. Minneapolis Ave., Wichita, Kans. *Noctuidae.*
'10. WALKER, E. M., Dept. Biol., Univ. of Toronto, Toronto, Ont. Canada. (F. '14). *Odonata, Orthoptera.*
'25. Walker, Fred H., Box 456, Salem, Mass. *Bees.*
'23. Walker, Fred W., Box 92 Monticello, Fla. *Orthoptera, Dermaptera.*
'30. Walker, Harry G., Va. Truck Exp. Sta., Norfolk, Va. *Psyllidae.*
'29. Wall, Robert E., Dept. Ent., Agr. Exp. Sta., Mont. St. College, Bozeman, Mont. *Phalaenidae, Aphididae.*
'23. Wallace, Hugh, E., Box 703 Riverside, Calif.
'11. Wallis, J. B., 211 Waterloo St., Winnipeg, Canada. *Haliplidae, Dytiscidae, Gyrinidae.*
'25. Walton, L. B., Kenyon College, Gambier, Ohio. *Endomychidae, Thysanura.*
'17. Walton, Wm. R., Bur. Ent., Washington, D. C.
'25. Watson, S. A., Whittier College, Whittier, Calif. *Miridae, Hemiptera.*
'31. Watts, I. R., 900 E. 61st St., Cleveland, Ohio.
'16. Webber, Ray T., 17 East Highland Ave., Melrose Highlands, Mass. *Tachinidae.*
Ch. Webster, R. L., Agr. Exp. Sta., Pullman, Washington.
'28. Weed, Alfred, c/o John Powell & Co., Inc., 114 E. 32nd St., New York, N. Y. *Conopidae.*
Ch. WEED, CLARENCE M., State Normal School, Lowell, Mass. (F. '24).
'17. Weese, A. O., Dept. Zool., Univ. Okla., Norman, Okla. *Ecology.*
'18. Wehrle, L. P., 117 Olive Rd., Tucson, Ariz. *Coccidae, Aphididae.*
'17. Weigel, C. A., Bur. Ent., Dept. Agr., Washington, D. C. *Greenhouse Insects.*
'13. Weiss, Harry B., Dept. Agr., Trenton, New Jersey. *Ecology.*
'12. WELCH, P. S., Dept. Zool., Univ. Mich., Ann Arbor, Mich. (F. '20). *Aqatic. Insects.*
'07. Weld, Lewis H., East Falls Church, Virginia. *Cynipidae.*
'21. Wellhouse, Walter H., Dept. Ent., Iowa St. College, Ames, Iowa.
'21. West, L. S., Dept. Biol., Ballttle Creek College, Battle Creek, Mich. *Muscoid Diptera.*
'18. Whedon, A. D., 1145 Third St. N., Fargo, North Dakota. *Odonata.*
'22. Wheeler, Geo. C., Univ. Station, Grand Forks, N. Dakota. *Formicidae, Eucharidae.*
Ch. WHEELER, W. M., Bussey Inst., Forest Hills, Boston, Mass. (F. '07). *Formicidae.*
'25. Whelan, Don B., College of Agr., Univ. of Nebr., Lincoln, Nebr.
'29. White, R. M., Ent. Lab., Lethbridge, Alberta, Canada. *Leaf-mining Insects.*
'22. Whitehead, F. E., Agr. College, Stillwater, Okla.
'30. Whitten, Russell R., 1156 Main St., Melrose Highlands, Mass.
Ch. WICKHAM, H. F., 911 E. Iowa Ave., Iowa City, Iowa. (F. '14). *Coleoptera.*
'29. Wilbur, D. A., Kan. St. College, Manhattan, Kansas. *Homoptera, Cicadellidae.*
'24. Wilcox, Joseph, Box 233, Puyallup, Washington. *Asilidae, Rhynchophora.*

'21. Wiley, Grace O., Mus. Public Library, 10th & Hennepin Ave., Minneapolis, Minn. *Aquatic and Semi-aquatic Hemiptera.*
'32. Wilford, Bill H., School of Forestry and Conservation, Univ. of Mich., Ann Arbor, Mich.
'29. Will, Homer C., Juniata College, Huntingdon, Pa.
'27. Willard, H. F., Box 340, Honolulu, Hawaii.
'14. WILLIAMS, C. B., Rothemsted Experimental Station, Harpenden, England. (F. '20). *Thysanoptera.*
'30. Williams, Inez W., Fernard Hall, Amherst, Mass. *Morphology.*
'14. Williams, R. C., Jr., 4537 Pine St., Phila., Pa. *Hesperidae.*
'17. Williams, Samuel H., Dept. Zool., Univ. of Pittsburgh, Pittsburgh, Pa. *Coleoptera.*
Ch. WILLIAMSON, E. B., Bluffton, Indiana. (F. '14). *Odonata.*
'11. Williamson, Warren, R. F. D. 5, Galesburg, Ill.
'23. Willis, Warren J., 24824 89th Ave., Bellerose, N. Y. *Aquatic Insects.*
'23. Wilson, C. C., 600-26th St., Sacramento, Calif. *Orthoptera.*
'25. Wilson, F. H., Dept. Ent., Cornell Univ., Ithaca, N. Y. *Mallophaga.*
Ch. Wilson, Harley F., 1532 Univ. Ave., Madison, Wis. *Aphididae.*
'30. Wilson, John W., Watermelon & Ornamental Lab., Leesburg, Fla. *Acarina.*
'28. Windsor, Margaret, S. W. State Teachers College, Weatherford, Okla. *Stratiomyiidae.*
Ch. *Wirtner, M., 741 Railroad St., Johnstown, Pa. *Hemiptera.*
'25. Wisecup, C. B., Box 549, Sanford, Fla.
Ch. Woglum, R. S., Calif. Fruit Growers Exchange, Los Angeles, Calif.
'31. Woke, P. A., Box 291, Tallulah, La.
'08. Wolcott, Robt. H., Univ. of Nebr., Lincoln, Nebr. *Hydracarinae, Lepidoptera.*
'14. Wood, W. B., Plant Quar. & Control Admin., Washington, D. C.
'25. Woodruff, L. C., Dept. Ento. Cornell University, Ithaca, N. Y.
'13. Woods, W. C., Kent School, Kent. Conn. *Chrysomilidae.*
'30. Woodside, A. M., 627 W. Frederick St., Staunton, Va.
'17. Woodworth, Chas. W., 2237 Carlton St., Berkeley, Calif.
'22. Worthley, H. N., 222 Hartswick Ave., State College, Pa. *Tachinidae.*
'28. Wray, David L., Jr., Dept. Agr., Raleigh, N. Carolina. *Coleoptera, Embryology.*
'29. Wurster, C. Wm., 37 Washington Square, New York, N. Y.

'31. Yeager, J. F., Dept. Ent., Ia. St. College, Ames, Iowa. *Physiology.*
'28. Yeates, J. M., Tallulah, La.
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'28. Young, Hiram C., Box 1910, Tucson, Ariz.
'25. Young, M. T., Box 165, Tallulah, La.
'28. Young, Hiram C., Box 1910, Tucson, Ariz.
'17. Yuasa, Hachiro, College of Agr., Kyoto Imperial Univ., Kyoto, Japan. *Ecology.*

'27. Zebrowski, Geo., Buck Creek, Ind. *Acarina, Hemiptera.*
'21. Zerny, Hans, Wien I, Burgring 7, Austria. *Heterocera.*
'07. Zetek, James, Drawer Z, Balboa, Canal Zone. *Isoptera, Trypetidae.*
'30. Ziegler, Louis W., Agr. Exp. Sta., Gainesville, Fla.
'26. Zimmer, L. A., 804 Maple Ave., Napoleon, Ohio. *Parasitic Hymenoptera.*
'21. Zimmerman, Sarah K., 317 Kensington Ave., Astoria, Oregon.